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PLATE I



View of the human body, showing the position of the incision.



# PEDIATRICS

## THE HYGIENIC & MEDICAL TREATMENT OF CHILDREN

BY

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VOLUME FIRST.

*ILLUSTRATED WITH FULL-PAGE PLATES & ENGRAVINGS  
IN THE TEXT.*

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TO

NELSON SLATER BARTLETT,

IN RECOGNITION OF HIS INTEREST AND ENTHUSIASM  
IN PROMOTING

THE STUDY OF PEDIATRICS.





## PREFACE.

---

A FEW words are perhaps needed to explain what I have undertaken to do in the following pages, and the method of arrangement and classification which has been employed. There has been no attempt to make such classifications as infectious and non-infectious diseases, because our knowledge of the former is increasing the number of that class so rapidly that for me it no longer constitutes a practical division for teaching. The book begins with a consideration of the infant at birth, and follows it through its various stages of development up to puberty. After dwelling rather more at length on normal development than is usual in works on pediatrics, the abnormal conditions are discussed. Beginning with the diseases which would naturally be met with in the early periods of life, and devoting considerable space to my observations on the blood of infants and of young children, the diseases of the different organs are then considered.

With the exception of a few rare diseases of which it was impossible to get satisfactory types, the illustrations represent actual cases of my own, heretofore unpublished. The colored illustrations have received my closest attention, and the patients were seen personally with the artist, so as to insure accuracy.

The establishment of milk-laboratories during the last three years has marked a new era in preventive medicine, and has made possible the scientific feeding of infants. As I believe that the medical treatment of the various abnormal conditions arising in infants is in the future to be largely dietetic rather than by means of drugs, I have given unusual prominence to the part of the work which is devoted to feeding.

I have also endeavored, in conjunction with my colleagues in the American Pediatric Society, to simplify the nomenclature of the various diseases, in order that physicians in different localities should by using identical names be the better able to aid one another in their investigations. A revision of the nomenclature of gastro-enteric diseases and of those of the mouth was especially called for on account of the changes which have followed our increasing knowledge of the etiology of these diseases.

T. M. ROTCH.

BOSTON, MASS., October, 1895.





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# PEDIATRICS.

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## DIVISION I.

### INTRODUCTORY.—THE INFANT AT TERM.

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#### LECTURE I.

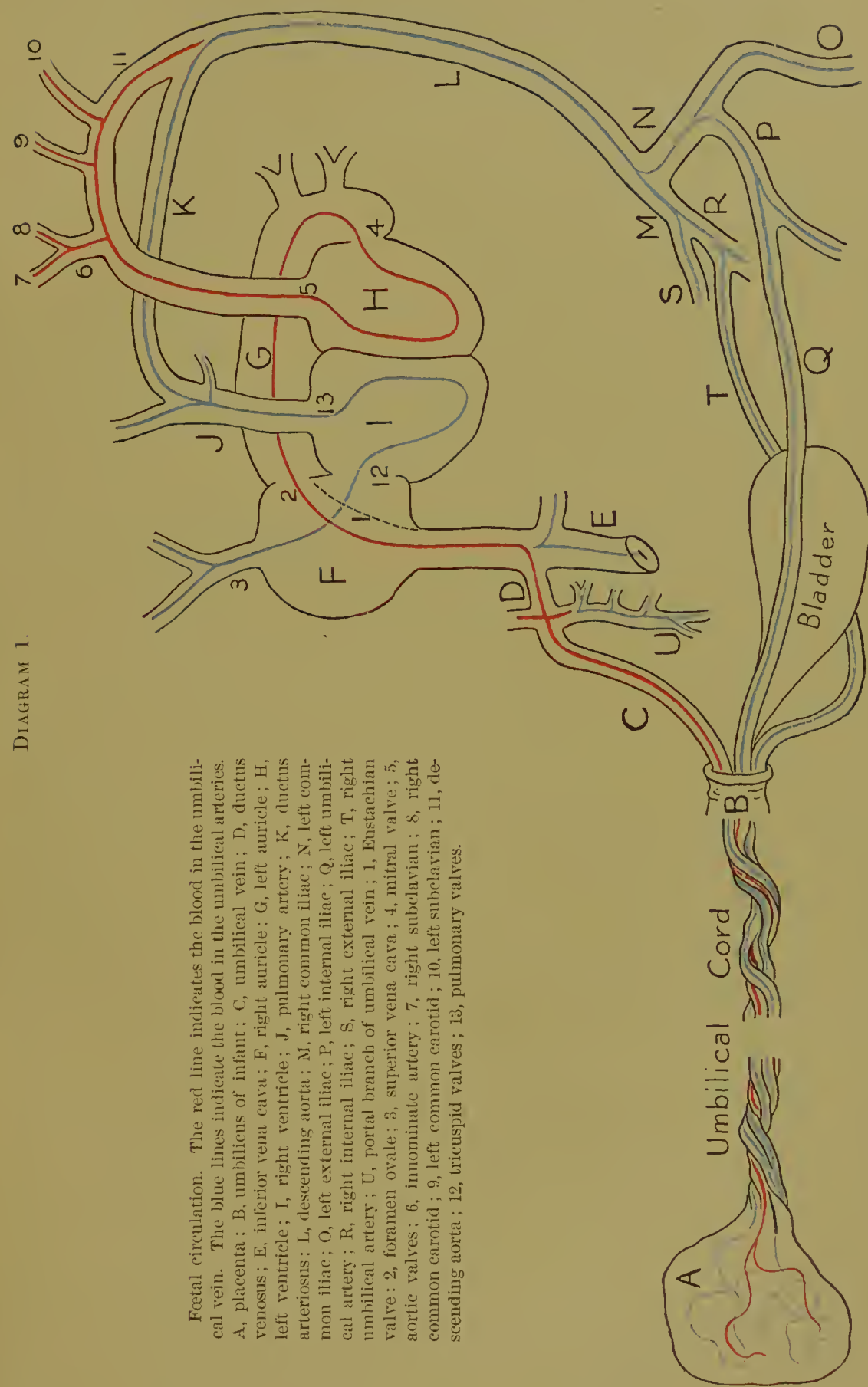
##### INTRODUCTORY.—THE FŒTAL CIRCULATION.

GENTLEMEN,—We are to-day beginning the study of a branch of medicine which will be of the greatest practical importance to you in your future careers. Those of you who enter into general practice will at once be called upon to treat infants and children. The proper appreciation of the sensitive temperaments and needs of this class of patients will be of great aid in successfully establishing your practice among those whose favorable opinion may make or mar your professional success. The difficulties to be surmounted in correctly diagnosing and treating young children are far greater than those which you encounter in adult life. The reason for this is that for adult cases you have some standard by which you can be guided, being yourselves adults. What standard, however, have you for the feelings and sensitive organization of the child? None within yourselves; it must all come from long and patient observation, with its resulting experience. The mere knowledge that certain diseases exist, and the usual methods of diagnosing them, prove to be very inadequate when we are brought face to face with a sick and fretful child, or with an infant who is unable to describe its symptoms. Much additional knowledge is needed to enable us to understand the variety of symptoms which may arise in the same disease according to the age and individuality of the patient. It is now well recognized that there is a necessity for making a special study of children beyond what is learned in the general clinical study of adults. As our knowledge advances, we learn to appreciate that the various methods of treatment must be modified to correspond not so much



to the special disease as to the special group of symptoms brought about by the age of the individual and the phase of its development. In studying, then, the different stages of development in children, we are in reality acquiring an alphabet, which when once thoroughly mastered will enable us to read the otherwise obscure language presented to us for translation by the various diseases of early life. The proper method of learning to understand sick infants and children is first to notice their peculiarities in health and to follow these peculiarities through the different stages of their development up to puberty. Thus, a pulse which would indicate an abnormal condition in the adult, or a convulsion which would be of serious import in the older subject, may often be but physiological or of slight consequence in the child. In fact, there are a large number of physiological and anatomical truths concerning the young the knowledge of which will simplify to a great degree otherwise almost insurmountable difficulties in diagnosis. The lack of this preliminary training, this alphabet, places the student who is endeavoring to understand diseases in children, in the position of attempting to read without having first learned his letters. It is our province in this course of lectures to begin with the human being at birth, to study it as it is presented to us in the early hours of life, and to follow it in its development during the periods of infancy and childhood up to the age of puberty. It then approaches so nearly in its development to the adult that its diseases assume the type of adolescence, and your studies carry you into the province of general clinical medicine. For purposes of simplicity, we speak of infants and children, the anatomical and physiological conditions being sufficiently apparent to warrant this distinction between them. The period of infancy is usually spoken of as covering about the first two years of life. Its most distinctive features are presented in the first twelve months, the second year, month by month, rapidly approaching the conditions which exist in childhood. The second year, however, is influenced to such a degree by the various growing functions and tissues that its picture both in health and in disease resembles more closely the infant than the child. Childhood is empirically reckoned from the end of infancy to puberty, or the beginning of adolescence. A distinction must be made between the sexes, the girl becoming a fully-developed woman some years before the boy becomes a man. The age of puberty is usually reckoned as beginning from the twelfth to the fourteenth year. Much latitude as to age, however, must be given for the special idiosyncrasy of the individual, and also for the climate, as it has been found that children who live in a warm climate arrive at the age of puberty much earlier than those who are exposed to the lower ranges of temperature. In taking the period of birth as a starting-point for our studies we must not overlook the fact that it is simply a stage of development with which we are dealing, and not a perfected being. The better, therefore, you understand the evolution of the embryo to the infant, the better will you be prepared to appreciate the evolution of the infant to the child and of the child to the adult. It is especially important

DIAGRAM 1.



Fœtal circulation. The red line indicates the blood in the umbilical vein. The blue lines indicate the blood in the umbilical arteries. A, placenta; B, umbilicus of infant; C, umbilical vein; D, ductus venosus; E, inferior vena cava; F, right auricle; G, left auricle; H, left ventricle; I, right ventricle; J, pulmonary artery; K, ductus arteriosus; L, descending aorta; M, right common iliac; N, left common iliac; O, left external iliac; P, left internal iliac; Q, left umbilical artery; R, right internal iliac; S, right external iliac; T, right umbilical artery; U, portal branch of umbilical vein; V, Eustachian valve; W, foramen ovale; X, superior vena cava; Y, mitral valve; Z, aortic valves; 1, innominate artery; 2, right subclavian; 3, right common carotid; 4, left common carotid; 5, left subclavian; 6, left common carotid; 7, left subclavian; 8, descending aorta; 9, tricuspid valves; 10, pulmonary valves; 11, tricuspid valves; 12, tricuspid valves; 13, pulmonary valves.



to understand the stage of development which exists just before birth, for on this depends the knowledge whether we have a physiologically and anatomically normal being before us, or one that is abnormal. Remember that disease does not merely mean a pathological change in the tissues, but, as is especially well exemplified in the infant, may simply mean a retardation or arrest of development. Thus, what would be perfectly normal anatomically at the seventh month of intra-uterine life may at birth be abnormal, and hence constitute a disease. In like manner what may be normal at birth may if it persists into the second and third weeks become an abnormal condition. Disease, therefore, is a relative term. We may, however, simplify our classification of diseases by adopting two broad divisions corresponding to the changes which take place during intra- and extra-uterine life. By congenital diseases we mean those resulting from changes occurring during intra-uterine life. These may arise from an arrest of development or from a continuation of normal intra-uterine conditions beyond the usual period of their cessation; also those which are caused by pathological processes such as inflammation. By acquired, we mean a pathological condition of existing tissues occurring after birth, and without regard to the stage of development.

If we thoroughly understand the anatomical conditions existing just before birth, we can intelligently examine the young human being as it emerges from the uterus, and can judge in the early days of its existence whether we have under our care a normal infant or one that is to need special treatment.

**FŒTAL CIRCULATION.**—The chief anatomical change which takes place at birth is the transition from the intra-uterine circulatory mechanism to a form adapted to extra-uterine life; in other words, from the oxygenation of the blood through the placenta to the same process carried on by the lungs. A general knowledge of the foetal circulation is, then, evidently of considerable importance for you to acquire, especially when you consider that a large proportion of the cases of congenital heart disease which you will be called upon to diagnosticate is represented by perfectly normal pre-natal conditions, such as *absence of the ventricular septum*, an *open ductus arteriosus*, or a *patent foramen ovale*.

This diagram (Diagram 1) represents the course of the (red) oxygenated blood from the placenta to the infant, and that of the darker (blue) deoxygenated blood from the infant back to the placenta. We must consider that in the foetus the lungs are in a collapsed, inert condition, performing no part in the foetal economy, but remaining quiescent until called upon to perform their special function at birth. The true lung of the foetus, therefore, is represented by the placenta of the mother. It is here that the blood is oxygenated, and is carried by means of the umbilical vein directly through the umbilicus of the foetus to the liver, as seen in the diagram. In the liver, the umbilical vein divides into three branches: (1) the smallest, carries the blood directly to the liver tissue, whence it is returned as in the adult to the inferior



cava by the hepatic veins ; (2) the largest portion meets and mixes with the blood from the portal system, and is distributed with it to the liver ; (3) the remaining portion is carried, by a vessel called the *ductus venosus*, directly to the inferior cava, where it meets the deoxidized blood from the lower extremities, mixes with it, and is carried to the right auricle : here, instead of passing as in the adult into the right ventricle, it is directed by a membrane, called the *Eustachian valve*, through an opening between the two auricles, called the *foramen ovale*, into the left auricle. It then passes into the left ventricle through the mitral valve, and thence through the aortic valve into the aorta. The greater part of the blood-current is then carried by the carotid and subclavian arteries to the head and upper extremities, where, after doing its work in vitalizing the tissues and taking up their waste (a small portion also passing, as usual, into the descending aorta), it is returned as deoxidized blood through the veins to the superior cava into the right auricle, thence through the tricuspid valves into the right ventricle, and up through the pulmonary artery, where a small portion is distributed as usual to the lungs, while the remaining portion is carried directly over to the descending aorta by a vessel called the *ductus arteriosus*. It here mixes with the small portion of oxygenated aortic blood mentioned above, and passes down the aorta, being distributed on its way, as in the adult, until it reaches the internal iliac arteries. From these arteries it is carried, by branches called the *umbilical arteries*, through the umbilicus back to the cord and placenta. Thus, by simply referring to this diagram, we can tell at a glance which part of the young infant should be most developed, and the reasons for it. A noticeable point of clinical interest, in tracing the course of the foetal circulation, is that the fresh oxygenated blood is mainly carried to the liver, head, and upper extremities, while the devitalized blood is distributed to the thorax and lower extremities. We should therefore expect, and we shall find it to be true, when we examine a normal new-born infant, that the head is larger than the thorax, that the abdomen is prominent from containing the large liver, and that the legs are insignificant and poorly developed.

When the placental circulation is cut off, an increased amount of blood is carried by the pulmonary artery to the lungs, and by degrees the foetal circulation is replaced by that of extra-uterine life.

The *ductus venosus* and *ductus arteriosus* become fibrous cords.

The *Eustachian valve* disappears.

The *foramen ovale* closes.

The *umbilical vein* and *umbilical arteries* become obliterated, with the exception of the lower parts of the latter.

All these changes, however, do not take place simultaneously, which is a point to be remembered in making a differential diagnosis of cardiac disease during the first ten days of infancy. We should therefore endeavor to bear in mind at about what time these changes take place. The following table will, I think, assist you in accomplishing this :

TABLE 1.

## POST-NATAL CHANGES OF FETAL CONDITIONS.

**Ductus Venosus.**—The ductus venosus becomes a fibrous cord in the fissure of the ductus venosus in from two to five days.

**Eustachian Valve.**—The intra-uterine function of the Eustachian valve practically disappears at once at birth, but its remains can be found for an indefinite period, as you see in this heart dissected by Dr. F. Dexter (Fig. 19, facing page 74).

**Foramen Ovale.**—The foramen ovale usually closes about the tenth day, but the upper part sometimes never closes. The closed foramen ovale is seen in this same heart dissected by Dr. F. Dexter (Fig. 19, facing page 74).

**Ductus Arteriosus.**—The ductus arteriosus is about 1.5 cm. ( $\frac{3}{4}$  inch) long, has a diameter of about .25 cm. ( $\frac{1}{8}$  inch), and is usually, so far as being pervious to the blood is concerned, obliterated in from four to ten days. Its remains, forming a fibrous cord connecting the pulmonary artery and the aorta, can be seen in this heart dissected by Dr. F. Dexter (Fig 20, facing page 74).

**Umbilical Vein.**—The umbilical vein becomes the round ligament of the liver, and is obliterated in from two to five days. As pointed out by Jacobi, it differs from the arteries very much less than is usual with the veins and arteries in other parts of the body. Its muscular layer is very large and strong.

**Umbilical Arteries.**—The umbilical arteries in their upper parts become obliterated in from two to five days, forming the anterior true ligaments of the bladder, while the lower parts remain pervious and form the superior vesical arteries. The umbilical arteries are usually thick and strong, owing to the great development of their muscular layer.

Thus you will observe that during the first two weeks of infancy we

FIG. 1.



Heart, natural size, at two days. A marks the aorta; PA marks the pulmonary artery; DA marks the ductus arteriosus.

may have conditions existing physiologically which after that time would become pathological, and hence, to be well grounded in the diagnosis of

disease in the infant, we must appreciate the importance of these facts and retain them for future use.

The heart is the organ on which, from the importance of its function to the system in general, our interest is at once centred at birth. It is well, therefore, for you to know exactly how it should look normally, and how large it should be.

This heart (Fig. 1, page 21) was taken from an infant two days old ; it is of normal size, and shows the *ductus arteriosus* connecting the *aorta* and the *pulmonary artery*.

This metallic injection of the heart and blood-vessels of the fœtus (Fig. 2), made by Dr. S. J. Mixter, shows you very clearly the *ductus arteriosus* and the ramifications of the various branches of the *pulmonary artery* and the *aorta*.

You must, of course, remember that where a cavity existed in the heart and vessels of the fœtus, the metal preparation shows a solid mass. Thus you can learn exactly the appearance of the inner surfaces of the right and left auricles and ventricles, the pulmonary artery, the ductus arteriosus, and the aorta.

FIG. 2.



Metallic injection of foetal heart and blood-vessels: A marks the aorta; PA marks the pulmonary artery; DA marks the ductus arteriosus.





## LECTURE II.

## THE INFANT AT TERM.

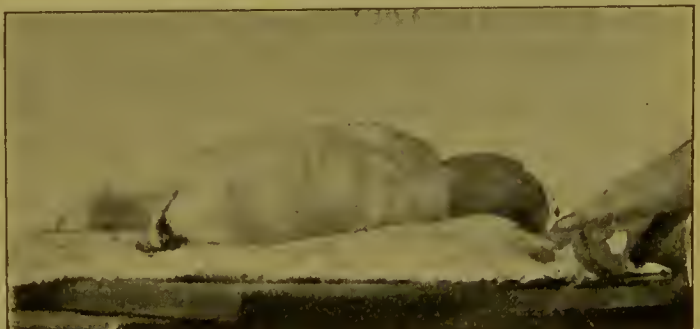
VERNIX CASEOSA—CORD—SPINE—NECK—HEAD—THORAX—ABDOMEN—TEMPERATURE—PULSE—RESPIRATION—HEIGHT—WEIGHT—VITALITY—HANDS—FEET—BONE MARROW—FUNCTIONS—BLOOD—LYMPHATIC SYSTEM—URINE—INTESTINAL DISCHARGES.

By the infant at term we mean one that has been born at the termination of what is considered the usual period of pregnancy, two hundred and eighty days.

I shall by showing you actual cases of normally developed infants in the early days of life endeavor to teach you what conditions are important for you to remember as distinguishing marks from the abnormal cases which I shall present for your inspection later.

This infant (Case 1), one hour old, represents the appearance of a normally developed fœtus when it first emerges from the uterus. The reddened skin, as you see, is covered in many parts thickly by a substance made up of the contents of the amniotic sac, in which the fœtus has been floating, and of the excretion of the sebaceous glands. This substance, which is called the *vernix caseosa*, must be removed in order that we may study the infant as it normally appears in the first stage of its existence. It is evident, however, that the infant is born with highly developed sebaceous glands, which at times produce a secretion so excessive as to be difficult to get rid of. In certain rare cases also this sebaceous matter is so universal and so impenetrable as to constitute a disease of serious import, and at times even to cause death. Infants are also born with the skin almost entirely free from the *vernix caseosa*, so that it is not necessarily present, and in fact I have had to wait for some time before I could get a subject which would present this condition sufficiently marked for illustration. You will also notice the dark fœcal discharge, called meconium, which is coming from the anus, and which is so characteristic of the early hours of life.

CASE 1.



Infant immediately after birth, covered almost entirely with the vernix caseosa, and having a discharge of meconium.

This infant was shown to you merely to represent the *vernix caseosa*, while what we are especially called upon to deal with is the new-born infant freed from its amniotic covering and with its entire surface prepared for our inspection.

For the purpose of illustrating this condition I will now show you another infant (Case 2, Frontispiece):

A male, two days old. Its birth-weight was 3800 grammes ( $8\frac{1}{2}$  pounds); its length is 480 mm. (19 inches); the circumference of its head is 34 cm. ( $13\frac{1}{2}$  inches); the circumference

of its thorax is 33 cm. (13 inches); and the circumference of its abdomen is 35.5 cm. (14 inches).

The infant has just been bathed, and presents the color of a healthy skin reacting normally to the temperature of the water, 36.6° C. (98° F.), and that of the room, 21.1° C. (70° F.). I have chosen this particular case as representing best what a strong healthy infant should look like. I shall presently show you that it is somewhat larger than the average infant at two days. In reality, however, so far as my experience goes, the size of this infant corresponds very closely to that of most healthy infants that are born outside of hospitals in families who live in comfortable homes of their own and in healthy localities. The delicate pink of the skin, the well-rounded body and limbs, the vigorous cry, the warm extremities, already beginning to move with activity, and the strong grasp of the little hands, all justify me in showing you what at this age may be looked upon as the picture of health.

The hair at birth is often thick, dark, and quite long, perhaps 2 to 5 cm. (1 or 2 inches); but we also frequently find the hair to be short, fine, some shade of light brown, small in amount, and, as you see on examining this infant's head, the temples to be bald and the hair to come down to a rounded point on the forehead. The eyes are almost always as you see in this case, half open when awake, expressionless, and of a dull grayish blue. Notice also what your study of the foetal circulation explained so well, the large head in comparison with the thorax, the arms more rounded and large in proportion to the legs, and the prominent abdomen.

**CORD.**—I have had the dressing removed in order that you should be able to study the cord minutely. You see how it is already drying up preparatory to falling off on the sixth or seventh day. The cord in health does not often receive much attention from the physician, and usually it is familiar in its appearance to the nurse only. Yet it is quite important for you to know how it should look normally up to the day when it separates from the umbilicus, for at times you are called upon to decide whether it is diseased, and unless you are familiar with it in health your opinion will not be of much value as to whether you have an abnormal condition before you. You see the slightly reddened areola where it joins and is to part from the abdominal wall. The three vessels are easily picked out, and differ in color. The two dark, almost black, lines twisting in and out around the single greenish-yellow and broader line are the umbilical arteries. The flat yellow line is what remains of the umbilical vein.

Palpation, percussion, and auscultation show that the heart has about the same proportionate position in reference to the lungs as is found in the adult, but that the liver occupies much more space, coming fully 1 to 2 cm. ( $\frac{1}{2}$  to 1 inch) below the edge of the ribs in the right hypochondriac and the epigastric regions, and encroaching on the lung-space in the right back to the extent of fully one rib and interspace. The testicles have descended, and the bladder, which is evidently full of urine, presents an area of dulness of

about 2 cm. (1 inch), just above the pubes in the median line. This corroborates the important fact, to which I shall refer later, that the bladder is an abdominal rather than a pelvic organ in the infant and the young child. The dull area of the spleen corresponds in its position to that found in the adult, but is scarcely perceptible.

I should like you to retain carefully in your minds this perfect picture of a human being at term, for it is the central point from which will diverge many interesting conditions of the later and higher development which I have undertaken to elucidate for you in these lectures.

We shall next study more in detail certain anatomical and physiological truths relating to the infant at term, but having reference to what is usually found to exist in the average infant rather than in the individual.

The figures which I shall present to you must necessarily be accepted in a general way, and will often be found lacking in exactness simply because there are so many exceptions to general rules taken from large numbers of cases. In my own experience, however, they have proved to be so near to the truth as to be exceedingly valuable in my clinical work. I have for many years had them verified in a number of large clinics and in my private practice, and they at least form a very fair basis for you to start with.

I shall now call your attention in a general way to a number of new-born infants of various weights and degrees of development, and show you that there are certain characteristics common to them all and corresponding to the period of birth. I am especially indebted to Professor Thomas Dwight for the assistance which he has given me through his own original investigations and for his verification of my clinical and anatomical work, the results of which I shall now lay before you. You must pardon me if, for the purpose of impressing upon you what I consider of absolute importance, I seem to repeat unnecessarily at times.

Remember also that I do not attempt nor deem it wise to give you the complete anatomy and physiology of the period of life we are studying. I shall merely pick out for your use the practical points in these periods which will aid you in clinical diagnosis and treatment. The great importance of thoroughly understanding the normal anatomy and physiology of human beings before attempting to deal with the morbid conditions which arise in them is now so well recognized that no preliminary remarks are needed to show how vital to all advance in clinical medicine is the proper reading of anatomical and physiological truths. There are several points in the anatomy and physiology of the new-born infant which would be better understood if the fact were borne in mind that in many respects the body at this age is more adapted to its intra-uterine life and to its means of exit into the external world than to the conditions which surround it in extra-uterine life.

Notice these infants a few hours old, as they are held up for your inspection by the nurses. By having one with its face (Case 3) and the



other with its back (Case 4) towards you, you can easily follow what I am about to tell you of the anatomical conditions characteristic of this early period of life.

This infant's (Case 3) face is, as you see, swollen and the features are out of shape. This condition is not uncommon at birth: it comes from pressure, and will soon pass off.

The cord, you see, has already been dressed with cotton.

The anatomical points so evident at birth as belonging to intra-uterine life, and the peculiarities of the foetal circulation, I have already dwelt upon, and I shall now point out to you the characteristics of the new-born trunk. This is egg-shaped, the larger end being below. The pelvis as a region hardly exists, and the thorax is very small when compared with the large abdomen. The latter is very large, owing to the disproportionate development of the liver, presumably a great organ of nutrition during foetal life. A striking peculiarity is the almost complete absence of shoulders, which with the arms are relatively insignificant outgrowths from the sharp end of the egg. I shall later consider the thorax in detail, but I may now mention that it is evident that its small size, its want of solidity, and the slight development of the pectoral and shoulder muscles indicate that its action in respiration must be very different from that in adult life.

The greatest breadth of the trunk is in the region of the lower ribs.

During intra-uterine life, and especially at the time of delivery, great flexibility and compressibility are requisite. Respiration has not yet occurred, and the assimilation of nutriment for the growth of the body and for preparing the rudiments of future organs has been the function most actively employed. When, therefore, we study the new-born infant we must remember that we see it at an essentially transitional stage. Adaptations, the marked utility of which is past, still persist, and new functions are carried on with very imperfect apparatus. These general principles having been stated, I can now discuss more in detail the spine.

**SPINE.**—One of the most beautiful of anatomical preparations is this cleanly dissected spine of an infant at birth suspended in a jar of alcohol (Fig. 3).

Owing to the removal of the other parts, its shape (if there be any at this age) is lost, but it is excellent for the study of the component parts. It is a wonder of lightness and flexibility. There is little bone and much cartilage and fibrous tissue. It can be twisted and bent at will in any direction. Looked at critically, it appears relatively broader in proportion to its length than does the adult spine. The height of the vertebrae is relatively less, and appears even less than it is, from the fact that the broad, narrow, bony nucleus of the vertebral body, which catches the eye, does not represent the whole thickness of the body, as it is embedded in cartilage.

At this early stage of development the whole column is cartilaginous, with the exception of the nuclei of the bodies of the vertebrae and those of

CASE 3.



Normal new-born infant : front.

CASE 4.



Normal new-born infant : back.





the laminae on either side, forming a small portion of the body and the beginning of the arch.

The time of the consolidation of the bodies is not accurately known, but this will be spoken of in the lecture on development.

In the young embryo, the proportion of the neck in the movable part of the spine is greater than that of the loins, a condition which is reversed in the adult, where the neck is less, being a little over one-fifth, and the loins a little less than one-third. In fact, the proportions of the spine change considerably from an early period of intra-uterine life to that of the perfected adult condition. At birth, however, the change has progressed sufficiently to make these two parts very nearly equal. The union of the laminae to form the spine begins in the upper part of the spine sooner than in the lumbar region. Throughout the greater part they are nearly united, and in some places are quite joined, at birth.

I mention these details not expecting you to remember them, but for future reference in cases where the spine is involved in diagnosis, and perhaps for intelligent orthopedic treatment. What I am about to tell you will also be valuable in directing the care of the normal child in regard to its sitting and standing. You see on examining these infants (Cases 3 and 4) how pliable and easily bent in all directions is the spine, and how their backs can be made to take almost any curve.

You will also understand better what I am about to say if you will examine closely this diagram of three spinal curves, representing (1) the natural curve at birth, (2) the curve which comes especially in the *cervical* region when the infant has learned to sit up and the superincumbent head has to be sup-

FIG. 3.

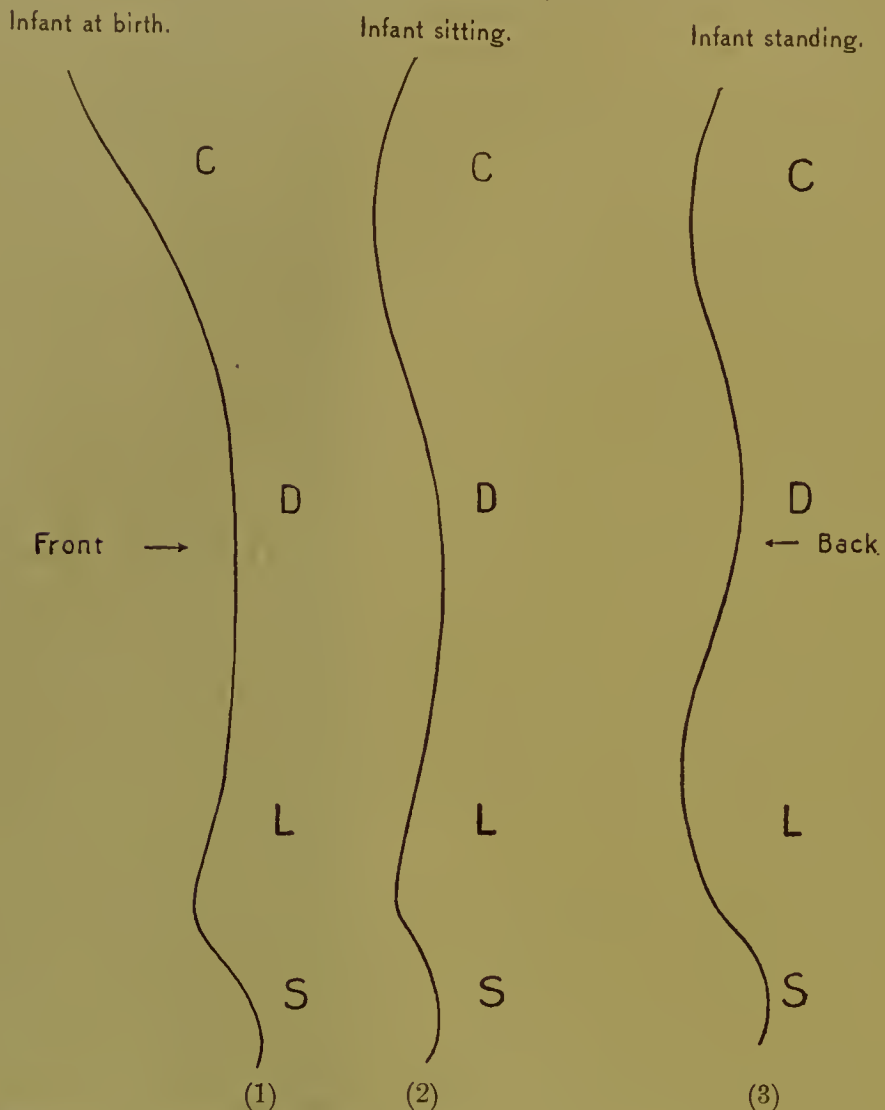


Dissection of the spine and pelvis in a newborn infant. Warren Museum, Harvard University.



ported, and (3) the additional *dorsal* and increased *lumbar* curves which appear when the child stands and walks, and which correspond to those of the adult condition.

DIAGRAM 2.  
SPINAL CURVES.



C represents cervical curve; D represents dorsal curve; L represents lumbar curve; S represents sacral curve.

A great deal has been written about the curves of the spine in new-born children, and their appearance in the embryo. Much of this literature is a monument of wasted ingenuity. The truth is, that at birth, when the child is lying in what may be called its normal position,—that is to say, on its side, with the head flexed and the thighs drawn up,—the whole spinal column presents one long concavity from the atlas to the coccyx, the front of which is subdivided into two curves by the slight projection of the promontory of the sacrum. Above this there is a tolerably regular concavity. The head can be thrown back so as to make a slight convexity in the neck, and by bringing the knees against the table (the infant being on its back) the lumbar region will spring forward; but the former of these positions is rather unnatural, and the latter impossible without assistance.

The concavity of the thoracic curve remains to be discussed, and this is the only one of the curves above the sacrum that can be said to have any real existence at this age. When, however, we analyze more fully the existence of this curve, we begin to doubt whether it is after all so very real, for, though the sternum and ribs have some retaining influence, it is possible by bending the body backward to obliterate this curve also. We can then consider the part of the spine above the sacrum as essentially a fibrous and cartilaginous rod with a number of separate disks of bone embedded in it at different places. The extent of the movements possible at birth, both in the dissected spine and in the whole body, is very remarkable, as is shown by these few experiments. The first was on the body of a female child at birth large and well nourished. The abdominal viscera having been removed, it was very easy to bend the head back so as to touch the buttocks. The head and extremities were then removed, the ribs cut near the junction of the cartilages, and the spine and pelvis roughly cleaned. It was then possible, by some straining, to bend the spine backward so that the atlas and coccyx met. It was, however, easy to bend it backward so as to make an arch, the atlas and coccyx resting on the table. It was noticed that the middle part of the spine was the most flexible, the dorsal concavity of after-life being easily changed into a convexity. The lumbar region appeared to be more pliant than the cervical. The point of greatest motion was apparently between the eleventh and twelfth dorsal vertebræ. The whole spine, with each of the cervical, dorsal, and lumbar regions, bends forward with about the same readiness that it does backward. It may at first appear surprising that it does not bend very much more when, as already said, we look on flexion as the normal position of the infant; but it must be remembered that this effect is largely due to the great head which bends forward on the spine, and that the above statement as applied to the spine after the head has been removed is more remarkable than appears at first sight. Lateral motion is very free, though it is not quite unmixed with torsion. The atlas can without effort be brought to the level of the sacrum either to the left or to the right. The bending is pretty regular through the different regions. In torsion, the sacrum being fixed, the spine could be twisted so that the atlas looked backward, and could even, with some straining, be carried through more than half a circle. From rather crude measurements it appeared that, under the above conditions, the rotation in the cervical region was through an arc of  $45^{\circ}$ , in the dorsal region  $90^{\circ}$ , and in the lumbar region  $45^{\circ}$ . Experiments were then made on the intact body of a girl thirteen years old. The head could easily be made to touch the heels, and it could be bent so as to fit into the middle of the back. Forward flexion appeared little greater than that of the adult, which is to be accounted for by the space taken by the head. When the pelvis was fixed, the head could be rotated through about three-quarters of a circle. The spine, thorax, and pelvis were next made into a ligamentous preparation, and the spine could then be bent backward until the atlas was almost within an inch of the pelvis. (It is to be

remembered that, unlike the last preparation, the sternum in this case was still in place.)

Under these conditions the spine could be flexed so as to make the atlas touch the upper end of the sternum and the pelvis the lower. Lateral motion was easy until it reached such a degree that the ribs on the flexed side came in contact. When the pelvis was fixed, the spine could easily be rotated through an arc of  $90^\circ$  without the action of the atlas.

Professor Dwight has pointed out the rather remarkable fact that at all ages, from birth upward, the spine of the fourth lumbar vertebra is (as in the adult) on a level with the highest point of the crest of the ilium. Under certain circumstances this might advantageously be used as a starting-point from which to count. At birth the spinal cord descends only the space of about one vertebra lower than in the adult. The third lumbar spine, which should mark its termination, cannot be easily recognized under three years, but the correspondence of the top of the ilium with the fourth vertebral spine allows its position to be estimated. It might be desirable to know how far the cavity of the spinal dura mater descends inside the sacrum. Recent investigations by Dr. R. Wagner show that in children under a year old it ends usually near the top of the third sacral vertebra, which makes it a little lower than its usual termination in the adult. The point on the surface corresponding to this could be approximately estimated without any definite landmarks.

**NECK.**—Now notice the large heads and short necks of these infants (Cases 3 and 4, facing page 26).

It is customary to say that young babies have no necks; and yet when speaking of the spine I stated that the cervical region of the vertebral column of the infant and young child is relatively longer than in the adult. From this point of view the shortness of the infant's neck must be seeming rather than real, but from a clinical stand-point it is real enough. The causes of the short neck are first the large head, which naturally falls forward, covering the upper portion, and next the high position of the sternum encroaching on it from below. The large proportion of subcutaneous fat tends to make the neck appear still shorter.

Symington, referring to the soft parts, says, "The peculiarity of this part of the child's neck is not that it is relatively short, but that it is higher in relation to the vertical column than in the adult." He has shown by a series of observations that the larynx is at first placed much higher than later. In the adult the lower border of the cricoid is about on a level with the top of the seventh vertebra. In the infant it usually seems to be near the lower border of the fourth vertebra.

**HEAD.**—As a rule, if you take the measurements of the head over the middle of the forehead and around to the occipital protuberance, you will find that at birth the circumference is about 33 cm. (13 inches).

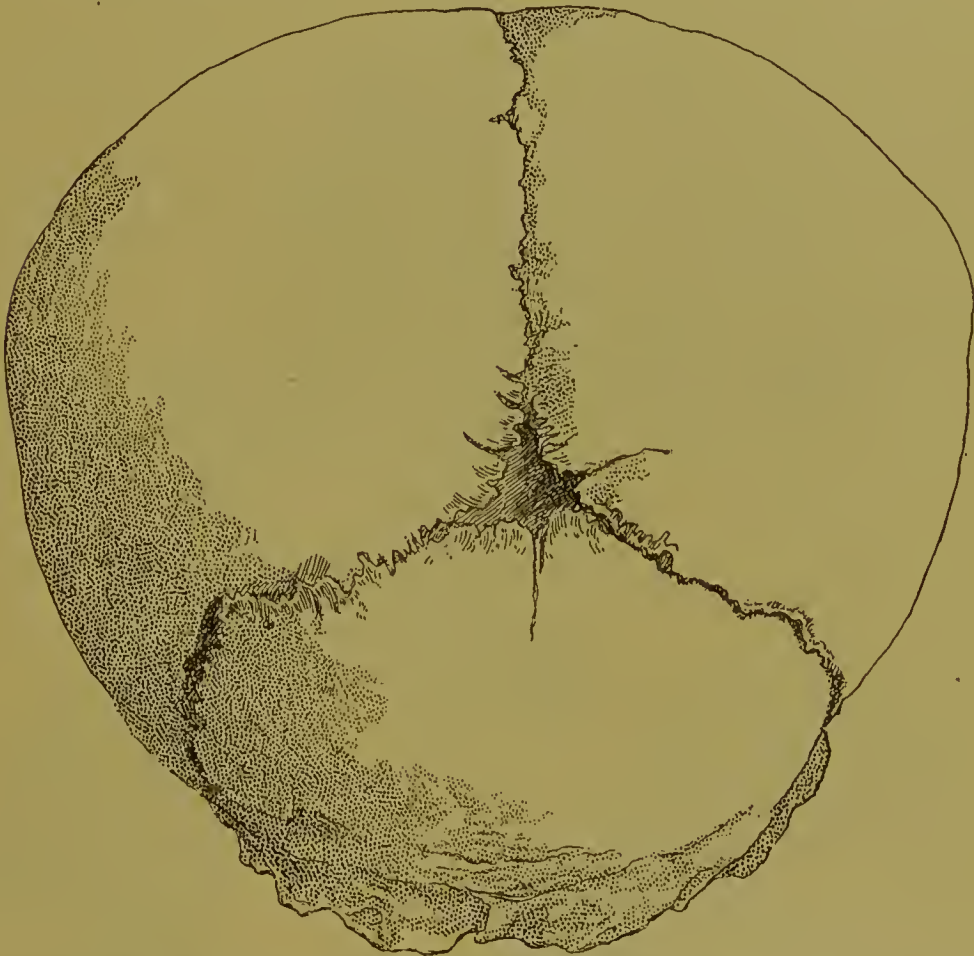
**FONTANELLES.**—The opening between the frontal bones and the anterior borders of the parietal bones is called the *anterior fontanelle*, and, though



somewhat depressed below the level of the bones at first, should soon be about on a level with them. Its size is variable, but is usually about 1 to 2 cm. ( $\frac{1}{2}$  to  $\frac{7}{8}$  inch) long, and about 1 cm. ( $\frac{1}{2}$  inch) wide. In the early days and even weeks of infancy the frontal suture is usually open in its upper part. The anterior fontanelle at term is well represented in this skeleton of the infant at term. (Lecture IV., Fig. 33, page 118.)

The opening between the occipital bone and the posterior edges of the parietal bones is much smaller, is of less significance than the anterior opening, is often temporarily obliterated by the overlapping of the bones, and is called the *posterior fontanelle*. You see it here beautifully shown in the skull of a new-born infant.

FIG. 4.



Skull of infant at term, natural size. Posterior view, showing parietal and occipital bones and posterior fontanelle. Warren Museum, Harvard University.

**FACE AND CRANIUM.**—You will notice that the proportion of the face to the cranium in these infants (Cases 3 and 4, facing page 26) is strikingly different from what we meet in adults, where it is as one to two, while according to Froiep the face in the infant is to the skull as one to eight.

If we contrast the front view of the face and cranium of the infant and of the adult by counting as face all below a line at the tops of the orbital arches, and as skull all that is seen above that line, considering it projected on a vertical plane as in a photograph, we find that in the infant the skull forms about one-half, and in the adult much less.



It is found that the height of the orbit bears pretty nearly the same proportion to the skull at all ages, but that it equals barely a third of the adult face, while it makes nearly a half of it at birth. While the top of the nasal opening retains pretty nearly the same relation to the orbit at all ages, its lower border is but very little below the lowest point of the orbit at birth, while it is much below it in the adult. In the latter, a line connecting the lowest points of the malar bones crosses the nasal cavity, or at least touches its lower border, while in the infant it runs almost half-way between the lower border and the edge of the alveolar process. The breadth of the skull in its greatest diameter in the infant equals, or even exceeds, the total height of the skull and the face, while in the adult it is but about three-quarters of it. Still more striking is the difference between the length and the breadth of the face at different stages. The breadth, measured between the most distant points of the zygomata, is to the height of the face in the adult about as nine to eight, while at birth it is perhaps as much as ten to four.

The side view is equally or even more characteristic. The auditory meatus is situated about midway between the front and the back in the infant, but in the adult it is decidedly behind the middle. The face appears to be but an insignificant part of the whole structure.

**Jaws.**—The lower jaw is almost on the same plane as the mastoid process of the temporal bone, and the upper border of the zygoma is about on a level with the floor of the nasal cavity, while in the adult it is at or near the level of the floor of the orbit. It is evident that a very important factor in the adult face is the development of the jaws and of the teeth, and that it is due to their rudimentary condition that the face is so small in infancy. The difference in the comparative development of the lower jaw at birth and at three years is well exemplified by these two skulls (Division II., Lecture III., Fig. 16, page 67).

**Gums.**—The gums do not meet in the new-born (McClellan). They are composed of a dense fibrous tissue covered by vascular mucous membrane of very slight sensibility, and are protective to the growing teeth.

All these points you will find of practical importance when you are asked to determine whether the face and skull at various ages are normal, or present some vice of formation.

Young infants frequently have at birth quite a startling shape to their heads, produced by pressure. One side of the skull may be flattened while the other bulges, or the natural diameters of the head may be altered, presenting a long narrow head instead of the round, well-formed cranium. These different shapes give at times an idiotic expression to the infant which causes much distress to the parents. In almost every case in my experience these abnormal appearances pass away as the skull and brain grow, and do not, as a rule, indicate disease unless very extreme, so that it is well to state this fact to the parents at once and thus to relieve their minds.

**NASO-PHARYNX.**—A knowledge of the change in size and shape of the nasal cavities and *naso-pharynx* in the course of growth is very important.

Valuable work has been done by Professor Disse on this subject. He divides the nasal cavity into the vestibule in front, the exit behind, and the intermediate portion, which consists of an upper olfactory region, occupying the ethmoidal portion of the cavity, and a lower respiratory region, occupying the maxillary part. In the infant the nasal cavity is relatively long and shallow, and the respiratory portion is very narrow.

These casts in fusible metal taken from the Warren Museum of the Harvard Medical School were made by Dr. S. J. Mixter, and, as you see, show a striking difference between the infant and the adult in the proportions of the inferior meatus.

FIG. 5.



IM marks inferior meatus ; IT marks inferior turbinate bone ; A marks antrum.  
Warren Museum, Harvard University.

Observe that in the adult preparation the metal runs deep under the inferior turbinate bone in the form of a long cylinder, while in the infant, though the inferior turbinate projects slightly into the nasal cavity, there is but a very minute expansion below it, and none passing up behind it.

According to Professor Dwight, the height of the posterior nares at birth is 6 to 7 mm., and the breadth between the pterygoid processes at the hard palate is 9 mm.

In infancy, the posterior border of the vomer is very oblique. Situated just behind the nasal cavity is the upper or nasal portion of the pharynx, which shares in its changes. I may perhaps be permitted to doubt whether many practitioners who have not had the advantage of modern anatomical teaching appreciate how small a cavity the naso-pharynx is even in the adult. Its height is twenty millimetres, and its antero-posterior diameter, from the hard palate back, is twenty to twenty-two millimetres. In the infant it is very much smaller. It is less of a vestibule and more of a narrow passage running obliquely backward and downward from the constricted opening of the posterior nares. The soft palate of the child seems to be placed more horizontally than in the adult, and bounds its anterior portion below. Kostanecki gives the height at birth as ten millimetres, and its antero-posterior diameter as fourteen or fifteen millimetres.

I do not give you Professor Dwight's observations on this point, as it seems to me that its shape is so peculiar that measurements are deceptive, or at least inadequate to give the proper idea. Imagine the posterior nares (not the inferior meatus alone, but the whole opening on either side) large enough to admit the end of a medium-sized male catheter, and that this leads into the passage just mentioned, and you can conceive how a congestion of the nasal mucous membrane in infancy, with the addition of the mucous secretion, may effectually close the opening from the nose to the pharynx.

It is, perhaps, not sufficiently recognized clinically how important a function is performed by the nasal passages in early infancy,—far more important, indeed, than at any other age. I can, in fact, say that the age of the infant is in inverse ratio to the dangers which may arise from obstruction of the nares.

These dangers, consequent on obstruction, congestion, and the resulting mechanical disturbance of neighboring parts, thus leading to actual disease of those parts, become in the new-born infant of most serious and even vital import.

In my own practice I have seen an infant die of simple acute nasal catarrh in the first two or three days of life. In this case the infant was, indeed, puny and ill cared for. Nothing abnormal could be detected in the throat, or, in fact, anywhere, except in the nares, which were completely occluded by the congestion and tumefaction resulting from an acute inflammation of the nasal mucous membrane. Occurring, as the case did, in the earlier years of my practice, I did not appreciate as I do now the extreme importance of the naso-pharyngeal function of the young subject. Therefore, after prescribing the usual remedies for such cases, on the second day of the infant's life, I was surprised to learn that it had died suddenly on the third day.

This unfortunate experience, however, served to draw my attention to



the proper treatment of this class of cases, and there is no doubt that, with due appreciation of the value of the nasal function and the danger of allowing it to be interfered with, we can, as a rule, even in extremely weak infants, prevent a fatal result.

I speak of this case in connection with the anatomical conditions of the naso-pharynx in order that you should appreciate the fact that these details, which are somewhat difficult to remember, are not merely of theoretical interest, but have a practical bearing on disease. I shall also refer to this case and its proper treatment in a later lecture when we are considering diseases of the throat and nose.

**Lymph-Vessels of the Pharynx.**—An anatomical condition of great importance, which I shall especially dwell on when I speak of pharyngeal diphtheria, is that in comparison with the faucial tonsils, which are relatively poor in absorbents, we find an exceedingly rich plexus of absorbents in the posterior wall of the naso-pharynx.

**Eustachian Tubes.**—The Eustachian tube in its clinical aspect is so closely associated with the naso-pharynx that it can best be spoken of in connection with it. In the foetus the nasal opening is below the level of the hard palate, which it reaches at birth. While in the adult the cartilaginous portion slants downward, nevertheless the opening of the tube is opposite a higher part of the nose than in the child. At birth the tube is horizontal or nearly so.

Professor Dwight has shown me the opening of the Eustachian tube at birth just above the level of the hard palate, and, in a child a year or more old, a little below the line of the palate. This statement may perhaps be misleading. It must be borne in mind that even if the opening of the tube be below the level of the hard palate, the soft palate none the less runs beneath it, shutting it off from the cavity of the mouth and the passage from it to the fauces.

In the infant and the young child there is but a slight development of the end of the cartilage which makes in the adult so prominent a fold at the back of the pharyngeal opening of the tube, and by its prominence does much to determine the depth of the fossa of Rosenmüller, the recess behind it at the lateral posterior angles of the pharynx. At birth this prominence hardly exists. The opening of the tube is at first very small. That the catheterization of the tube at this age presents great difficulties of its own, apart from the intractability of the patient, is sufficiently obvious.

The tube in infancy, while of course shorter than in the adult, is stated to be not only relatively, but absolutely, wider at its narrowest point, which may explain the ease with which catarrhal processes travel at that age to the middle ear.

**Faucial Tonsils—Pharyngeal Tonsil—Lymphoid Tissue.**—The faucial tonsils, the pharyngeal tonsil, the lymphoid masses under the mucous membrane of the posterior third of the tongue, the lymphoid tissue about the orifices of the Eustachian tubes, to say nothing of irregular aggregations



of the same tissue in the neighborhood, form a lymphoid ring around the pharynx which is most important. It is to be noticed that the passage from the nose, as well as that from the mouth, is guarded by this apparatus. That its function is in part protective seems very probable, in spite of the fact that when hypertrophied it gives rise to serious trouble. Before birth this system is but slightly developed. Indeed, the follicles at the back of the tongue are not always to be found at that time. I regret that Professor Dwight has not had material enough to aid me in adding much to the little that is known as to the progressive development of the tonsils. Killian states that the pharyngeal tonsil is at birth a raised bunch containing adenoid tissue with ridges running in various directions, often more or less converging to a point, and rarely running directly forward and backward.

A pocket in the pharyngeal tonsil is the famous *bursa pharyngea*. It is clinically important merely as a recess in which inflammation may linger and secretions be retained.

As for the physiology of the tonsils, in which I include all the adenoid tissue of this region, I will mention that Stöhr showed that leucocytes make their way from them through the mucous membrane to escape into the throat. This process begins with life. He found the infiltration of the surface of the tonsil of a child of three months much greater than in the case of new-born infants.

The supposition that this system is protective receives support from Killian's observation that the pharyngeal tonsil is much developed in mammals that live in the dust of houses. Metschnikoff's theory, that leucocytes devour bacteria, does not seem to be supported: nevertheless, it is not impossible that this lymphatic ring forms a bulwark against septic invasion.

Stöhr's observations of the escape of white corpuscles do not necessarily conflict with the view that the tonsils absorb the secretions of the parts in front. If these secretions are irritating, inflammation of the tonsils may result. The effects of enlargement of the faucial tonsils are well known; those of hypertrophy of the pharyngeal tonsil have been recognized only within a few years. Indeed, I imagine that it has not been more than ten or twelve years since the general practitioner became aware of the existence of such a structure. The small size of the naso-pharynx in the infant and the young child must not be forgotten, for it explains its obliteration by the enlargement of the pharyngeal tonsil.

MOUTH.—I wish you now to get a general idea of the mouths of these young infants as I open them for your inspection. You see the whitish, comparatively dry tongue, which, with the lips, cheeks, and roof of the mouth, immediately closes around the inserted finger and produces the sensation of sucking. The mouth, then, as a whole, is pre-eminently an organ intended for the reception of a liquid food, its mechanism being that of suction. It is a natural and necessary passage-way to the organs of digestion, but is not at first, as I shall explain to you later, intended to aid the digestion by a salivary secretion.

**Gums.**—The gums have already been described on page 32.

**Teeth.**—At birth there are twenty embryo teeth, ten in each jaw, enveloped in their respective tooth-sacs, protected above by the submucous tissue and mucous membrane, on either side by alveolar bone-substance, and below by the groove in the maxillary bone from which the alveoli have developed.

I do not propose to undertake a general description of the cavity of the mouth, but shall merely call attention to some especial points in connection with the discussion of the relations of the pharynx. A median section of the infant's head shows very strikingly the want of height of the naso-pharynx and the great obliquity (approaching the horizontal) of the posterior edge of the vomer. The naso-pharynx is relatively very long from before backward. Strange as it may seem, the distance from the back of the hard palate to the soft parts of the back of the pharynx (excluding the tonsil) is about as great at birth as in the adult.

This statement appears incredible, but is easily proved by measurement. The tongue of the infant is greatly wanting in vertical thickness, and is shown on such a section to be long and low. The soft palate rests, therefore, on the tongue, and, the mouth being closed, runs in the main backward, descending very much less than in the adult. The uvula is rudimentary (Merkel). It seems to me that, owing to the depth of the pharynx (from before backward), the soft palate is unable to shut off the passage to the naso-pharynx as completely in early infancy as subsequently.

It is very curious that, in spite of these peculiarities, the distance from the tip of the uvula to the top of the epiglottis is relatively as slight in the infant as later.

**HARD PALATE.**—I shall now call your attention to the level of the hard palate, and to what vertebræ are behind the mouth at different ages. This may be studied in connection with the position of the larynx already mentioned. We find by examining anatomical specimens that at birth and in the early months of life the line of the hard palate, continued backward, would strike near the top of the basi-occipital, that is, near its junction with the sphenoid, or perhaps even strike the latter. Accordingly, at this age, if the finger be introduced directly backward through the mouth, pushing the soft palate upward, it will strike the occipital bone, and, being carried a little downward, will pass over the arch of the atlas, the base of the odontoid, and the body proper of the axis. Going still lower, the top of the third cervical vertebra might be felt, but the larynx would hardly permit the finger to go lower, and the parts are so small that I doubt if much could be recognized below the axis.

**BRAIN.**—The brain of the new-born infant is proportionately very much larger than in the adult, bearing a relation of about 15 to 1. (Vierordt.)

**EYE.**—The eye is anatomically perfectly developed in the new-born. (McClellan.)

**EAR.**—The development of the ear, as stated by McClellan, is in its several parts very unequal. The structures of the internal ear, the tympanic



cavity, and the auditory ossicles are fully formed at birth, while the external auditory meatus, the Eustachian tube, and the mastoid portion of the temporal bone undergo many modifications before their full development at puberty. At birth the meatus passes inward and inclines downward, and the membrana tympani is almost horizontal, conditions to be remembered as necessitating a little different management of the ear speculum from what you are taught in the examination of the adult ear. (Vide Lecture III., page 65.)

The mastoid antrum exists at birth, but the cells do not develop until later.

**PETRO-SQUAMOSAL SUTURE.**—An important anatomical condition existing at birth is, that the *petro-squamosal suture* is open, allowing a close connection between the blood-vessels of the brain and the middle ear, with its resulting clinical significance.

**THORAX.**—The thorax of the infant forms the upper and smaller end of the egg-shaped body which I have already described the trunk as presenting. As I have pointed out, the small shoulders of the infant make the chest very different from that of the adult. Besides this, the whole shape of the thorax is very peculiar. The proportion of the dorsal region of the spinal column is pretty nearly the same throughout life, but the thorax itself varies greatly. At birth the thorax is very insignificant. In front the breast-bone is relatively much smaller than that of the adult male, but not very different from some very small breast-bones which are occasionally met with in women. I shall consider this in detail later, and I now merely mention that the lower part is but slightly developed. The borders of the ribs diverge relatively rapidly. This is perhaps due to the great breadth of the abdomen.

**TOP OF THE STERNUM.**—The sides of the thorax are not relatively so long as in the adult, which is probably partly due to the lesser development of the lower ribs and partly to the very important characteristic of the infant's thorax,—namely, that the top of the sternum is placed higher than in the adult. The top of the sternum in the latter is about on a level with the disk between the second and third dorsal vertebræ. The top of the sternum, according to Symington, is opposite about the middle of the first dorsal vertebra in the new-born infant, and a frozen section by Rüdinger shows it to be rather below the middle of the first.

**DIAMETERS.**—Another most important peculiarity of the infantile and child's thorax is its want of breadth. In the adult throughout the thorax, from about the level of the second costal cartilage, or even a little higher, to the top of the diaphragm, the antero-posterior diameter of the interior of the thorax is to the transverse as one to two and a half or one to three, there being, of course, a certain amount of variation. At birth, on the other hand, it is as two to three.

It is well known that in the infant the ribs are more nearly horizontal than in adult life. A striking feature of the young infant's chest is that the

ribs form the sides of the chest, and the sternum and cartilages the front. I will now give a more detailed description of the latter parts, which are of great importance for two reasons: first, on account of their influence on the type of respiration, and, secondly, because the costal cartilages are used as landmarks for the organs beneath them.

**OSSIFICATION.**—At birth the sternum is practically a strip of cartilage in which a varying number of bone-centres have been deposited. There is one for the manubrium and usually one or two for the second and third pieces, those for the latter being very frequently double. These, however, are mere thickenings of the cartilaginous strip, which is flexible and pliable in all directions. The divisions of the sternum in infancy are plainly seen in these skeletons, especially in the larger one, which is nineteen months old. (Lecture IV., Figs. 33 and 34, page 118.)

**MOVEMENT OF RIBS.**—A word as to the movements of the ribs will be of interest before we discuss the mechanism of respiration as a whole. The movements of the adult ribs are very imperfectly explained in many of the treatises on anatomy, and in others the explanation is labored and complicated. A ligamentous preparation of the spine, with a small piece of each rib *in situ*, shows the following state of affairs. The first rib moves up and down on a single axis running through the head of the rib resting against the body of the vertebra and its tubercle on the transverse process. This movement is a perfectly simple one, the front of the rib moving up and down, and no other movement is possible. In the second rib the conditions are practically the same; but in the third there appears a new feature, which is more developed farther down. It is that the tubercle of the rib no longer remains in place on the transverse process, but slides up and down on it, so that while the inner end of the axis remains stationary the outer end is raised (in respiration), and consequently we have, in addition to the raising of the forward end of the rib, a swinging upward of its outward convexity, which may be referred to a rotation on an imaginary antero-posterior axis. Skipping now to the last rib, which has no tubercle and rests on no transverse process, we find that we can raise or depress it, move it forward or backward, and circumduct it, by carrying it from one of these positions to another. This is true in a less degree of the eleventh rib, and perhaps to some extent of the tenth. The raising of the front of the ribs not only increases the antero-posterior diameter of the chest, but, by bringing the lateral convexity of each rib to a higher level, also increases the transverse diameter; this is further increased by the rotation of the longer ribs on an antero-posterior axis. The freedom of the lowest ribs allows them to be pulled backward and downward by the muscles of the back, thereby giving a firmer attachment to the diaphragm, and thus favoring its contraction, or they may be drawn inward by it or upward, following the outer ribs. It is to be remembered that in such a ligamentous preparation the movements are far more extensive than they can be in life, owing to the restraint exercised by the sternum and costal cartilages as well as by the



soft parts. The influence of the sternum is especially important, as in the adult the body is in one piece, and the amount of motion between it and the manubrium is probably not often great.

RESPIRATION.—An important feature in the mechanism of thoracic respiration is the rigidity of the thorax. In the infant at birth this rigidity is almost wholly absent, as it is found only in the ribs.

The sternum, as has already been said, is at this age practically a perfectly flexible strip of cartilage, for the small points of ossification in it only modify the softness of certain separate parts. The dorsal region of the spine is not fixed as a concavity, but can be bent freely backward. The motions of the ribs are, as Professor Dwight has satisfied me from our observations on the dissected spine, practically the same as in the adult, but the effect of these motions is different. In the first place, as has been shown, the ribs are more nearly horizontal, and the thorax, even after death, is in what is called the inspiratory condition. The nearly horizontal first rib can hardly rise any higher unless the whole spine is bent backward. The ribs, being straighter than in the adult, do not when raised increase the breadth of the chest to the same degree. The nature of the infantile respiratory movements is far from easy to analyze. Sometimes it seems abdominal and sometimes thoracic. The fact is, that at first it is of a very indefinite type. The thorax seems to expand as it can. It is common to see its lower part drawn inward by the contraction of the diaphragm.

An examination of the living subject during the different periods of infancy has been made by me with considerable interest, and my results coincide closely with what I had already been led to expect from my anatomical and physiological studies. At birth no especial part of the respiratory apparatus has attained a sufficient development to insure its continuous equable action, and I have therefore found, as would be expected, irregular respiratory movements and no decided type of respiration.

A sufficient number of observations, however, have not yet been made to warrant our stating any especial age at which the type of respiration in the two sexes separates and the female infant assumes the thoracic type of respiration. But if the breathing of the infant is essentially irregular in type, it is admirably adapted to the wants of its age. The elastic thorax can give way under pressure and expand in almost any direction. The flexible sternum submits to liberties which no adult breast-bone would endure. One-half of the chest may be compressed and yet the other go on acting independently.

The facts concerning the shape of the infant's thorax, which I have already pointed out,—namely, that the top of the sternum is higher, reckoning from the spine, that the ribs are more nearly horizontal, and that (probably) the lower part of the sternum is relatively less developed than in the adult,—necessarily imply certain peculiarities in the relations of the internal parts. There is, however, a difficulty in understanding and stating these peculiarities, which, though sufficiently evident, is often overlooked,

and which may occasion both obscurity and confusion. This is the want of a generally accepted standard by which to judge of the position of these parts. Is this standard to be the spine or the front of the chest? We cannot use both indiscriminately, for their relations differ with the age. It is clear that the spine is the more fixed point of the two, and therefore the better scientifically; but for most clinical purposes it is desirable to refer to the front of the body.

DIAPHRAGM.—I shall now speak of the position of the diaphragm. This, as is well known, rises highest on the right over the summit of the liver, is a little lower on the left, and lower still at its tendinous centre in the median line. It is generally stated that the diaphragm is higher in the child than in the adult. Dwight's observations, partly original, partly on the frozen sections of other writers, give the following result. In the infant the diaphragm appears to be opposite the disk between the eighth and ninth dorsal vertebræ.

We now come to the insertion of the front of the diaphragm. In the infant it appears as if there were a lower insertion of the diaphragm to the sternum and the seventh costal cartilages than in the adult. Usually the line runs from one costal arch to the other, somewhat above the apex of the ensiform cartilage, leaving, therefore, a space on either side of the latter, where the interior of the thorax is against the abdominal walls. It is remarkable how vague and various are the statements in anatomies on this point in the adult. The sternal origin of the diaphragm is said in some instances to arise from the ensiform near its base, and in others near its apex. Undoubtedly there is ground for both assertions. In the two well-known median frozen sections of the body by Braune, it arises in the male at the apex of the ensiform, and in the female near its base. I hesitate, therefore, to assert that there is any difference in the points of attachment in the infant, but the effect is different none the less. Owing, perhaps, to the greater flexibility of the body and to the less firm attachment of the internal parts one to another, it certainly seems that at least after death the thoracic cavity is more accessible at the sides of the ensiform than it is in the adult.

In the adult it may be as low as the middle of the tenth vertebra, but more often probably will be at the disk above it or the lower part of the ninth vertebra and occasionally higher. In Rüdinger's median section of a woman in the last months of pregnancy, it is as high as the lower border of the eighth. We may conclude that, while there is some variation, on the whole, the central point of the diaphragm is in the infant higher in relation to the spine than later in life, and that it gradually becomes lower. How high the diaphragm rises laterally is hard to say, for it is a point very difficult to observe. According to Kölliker, in the foetus at term, on the right, it reaches the level of the anterior end of the fourth cartilage, and on the left that of the fourth intercostal space. Henke adds to this quotation that certainly after respiration has begun it will never be so high again.

There is another point concerning the attachment of the diaphragm to



the front of the chest which will most conveniently be considered a little later: so, keeping this in reserve, I shall pass on to a consideration of the thoracic organs.

**THYMUS GLAND.**—The thymus gland exists at birth, and lies above and to some extent before the heart. It will be referred to later in the lecture on Development. (Fig. 18, page 73.)

**HEART.**—The most striking peculiarity of the infant's heart is that it is less covered by the lungs than in adult life. Together with the thymus gland it forms a solid mass from the posterior mediastinum to the sternum, pushing the lungs far apart. It is to be noticed, however, that the pleural cavities extend as far forward as in the adult. The relations of the heart to the chest-walls are curious in the infant, for these anterior walls are, as already stated, high in relation to the spine, yet the heart itself is high in relation to the walls. At least the upper half of it is so. With regard to the apex and the lower borders the relations are less certain. We usually

find the impulse of the heart rather higher and nearer to the mammary line in the infant than in the adult. The weight of the heart at birth is 20.6 grammes (about  $\frac{2}{3}$  ounce), according to Boyd, and its proportion to the rest of the body is largest at about the time of birth.

It will be well for you in this connection to examine again carefully this heart of the new-born infant which I have already shown you. (Lecture I., Fig. 1, page 21.) As the foramen ovale is so often open at birth, I should also like you to familiarize yourselves with what a patent

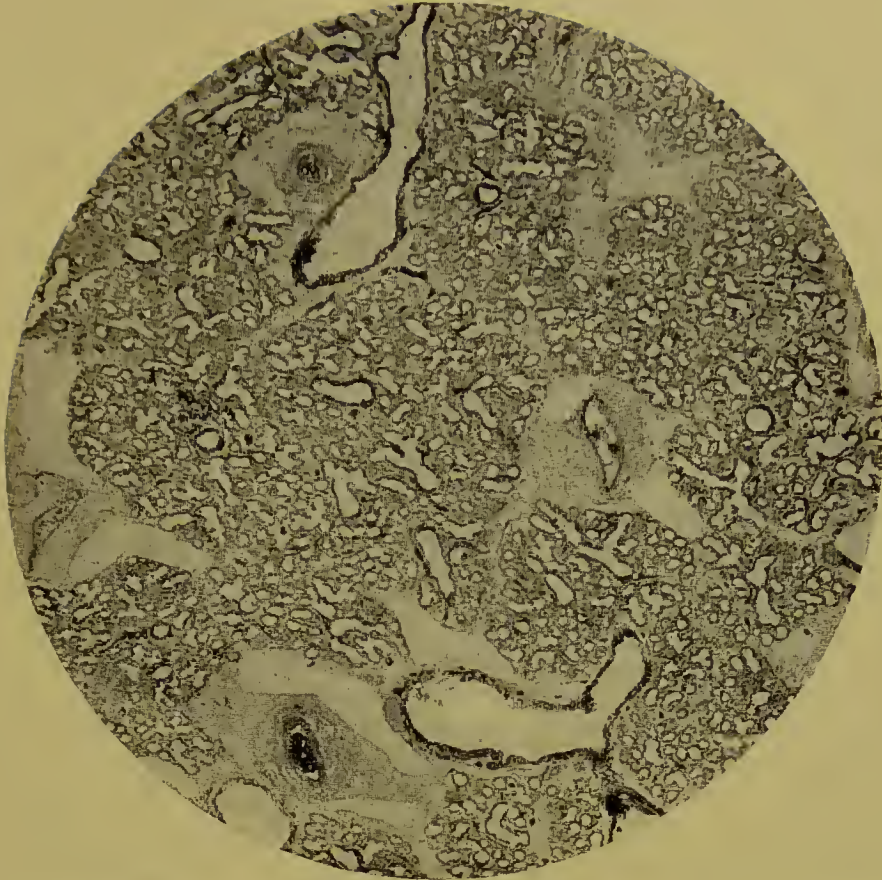
FIG. 6.



Right auricle and ventricle. Infant's heart. Open foramen ovale, marked F.O. Warren Museum, Harvard University.

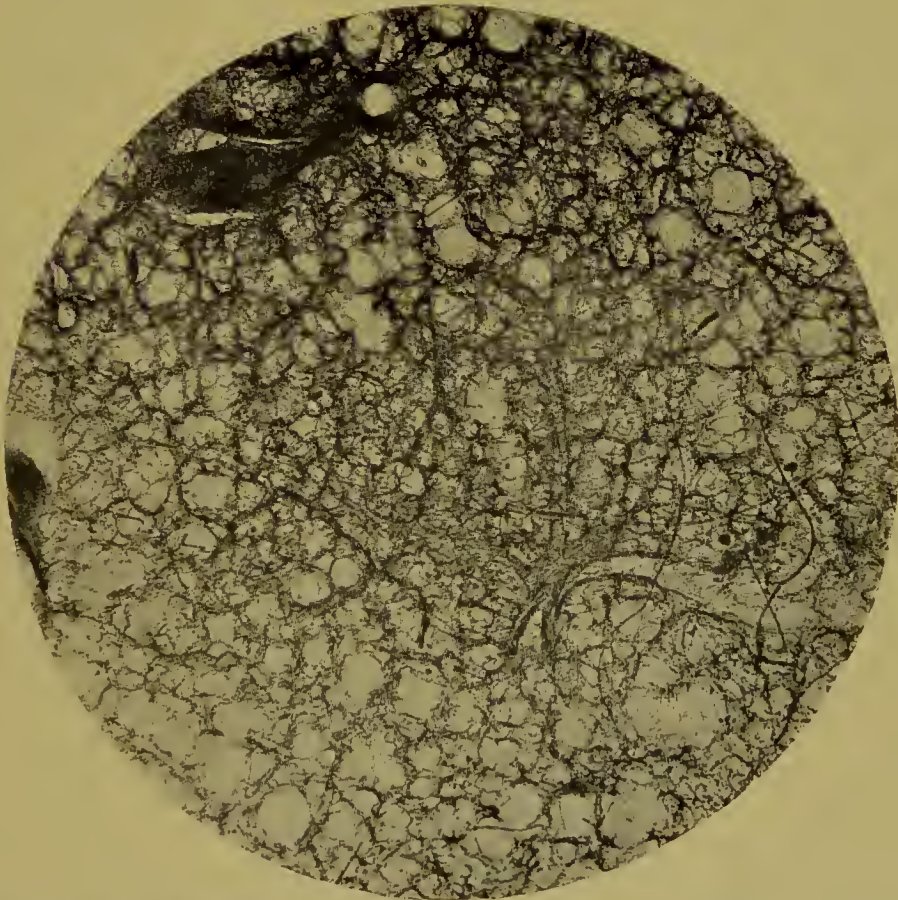
foramen ovale looks like, as seen in this specimen (Fig. 6) of an older infant's heart, where you see there is a free and permanent connection between the right and left auricles. The heart is slightly hypertrophied.

FIG. 7.



Section of fetal lung at 5 months, showing development of bronchi ; no alveoli.

FIG. 8.



Section of infant's lung at 10 months, showing increased proportionate amount of parenchyma in comparison with the fetal condition ; distended alveoli.





**COMMON CAROTID ARTERY.**—The common carotid artery has in the new-born half the length of the descending aorta, but this proportion is much lessened at a more advanced age, when the vertebral column increases in length.

**VEINS.**—According to Jacobi, there are one hundred valves in the veins of the lower extremities of the new-born.

**PULMONARY ARTERY.**—The pulmonary artery also, as stated by Jacobi, is from two to four centimetres (three-fourths to one and five-eighths inches) larger than the descending aorta.

**LUNG.**—I have already referred to the fact that the liver encroaches so much upon the space which on the right side of the thorax is occupied later by the lung that an important difference is found between the percussion of the right and the left lung. On the right side the eleventh rib behind marks the lower border of the lung, while it descends as low as the twelfth rib on the left side. In front the lung extends to about the fourth or fifth rib on the right side and the sixth rib on the left side. The lung at birth is characterized by its embryonic type. The infant's lung represents an intermediate condition of growth, which illustrates the gradual change from the foetal to the adult condition. These photo-micrographs (Figs. 7, 8, facing page 42), made by Northrup, of sections of a foetal lung at five months and of an infant's lung at ten months, explain the anatomical conditions at birth.

These conditions have been carefully studied by Northrup, who deserves great credit for the work which he has done on this subject, and which will be referred to later in the lecture on Development, and also in that on the Lungs. This author in speaking of the characteristics of the lung in infantile life says that if we examine the lung of a five months' foetus it is found that the bronchi constitute the entire respiratory tract thus far developed. At the terminal end of the bronchi there are bud-like dilatations, which are the rudimentary air-spaces. Between these dilatations, and separating them from each other, is loose, delicate connective tissue, which makes up the remaining bulk of the lung, so that what subsequently becomes the alveoli is about equal in extent to the previous bronchial development. This rudimentary air-space is destined to enlarge, subdivide, and finally, in early adult life, to occupy all the available room among the bronchial branches. The loose connective tissue becomes finally thin, dense bands constituting the stroma. This serves to distribute the vascular net-work, and upon this are laid the close-fitting epithelial linings of the air-spaces. In foetal life the mucous membrane lining the bronchial tubes is loosely attached to the muscular walls, and is commonly seen lying in wavy folds within the contractile ring, where the same delicate connective tissue loosely holds the growing tissues together. As has been said, the aerating portions of the lungs develop as bud-like dilatations at the tips of the smallest bronchi. These dilatations in the course of their development extend into the stroma. The epithelium, changing from the columnar type characteristic of the smaller bronchi, covers the newly-made walls with flat respiratory epithelium. At birth the loose connective-tissue stroma of the foetal lung of five months has

been condensed into rather thick alveolar walls. Another feature of the child's lungs as contrasted with those of adults is the behavior of the blood-vessels. Being loosely restrained in the walls, they easily become distended and tortuous and encroach upon the cavity of the alveoli. With small alveoli, thick walls, and abundant distribution of vessels, it is easy to understand how, in hypostasis, distention of the vessels may be an important factor in displacing the air in feeble subjects with weakened respiratory vigor and partially obstructed bronchi. Finally, the lung of the infant differs from that of the adult mainly in the following respects. Proportionately the extent of the bronchial tubes is greater than that of the air-spaces. The connective-tissue stroma is likewise in greater abundance and tends to cellular proliferation. The submucous connective tissue of the bronchi is loose and more abundantly supplied with nuclei, and its vessels are held more loosely. The cells lining the air-spaces form a continuous layer. The alveoli are small, their epithelium proliferates abundantly, and the absorbents accomplish their work slowly, the blood-vessels playing a more important rôle. These facts are to be borne in mind in connection with the bronchial lesion which forms so important a part of broncho-pneumonia.

**ABDOMEN.**—The essential differences between the abdomen of the infant and that of the adult are, *first*, the great size of the liver in the former.

**LIVER.**—This organ, especially on the right side of the abdomen, encroaches on the space which is later occupied by other organs. Its relative weight to that of the whole body at birth is about 1 to 18. (McClellan.)

**KIDNEY.**—*Second*, but of less importance, is the relatively large size of the kidney and the supra-renal capsules. On the left side of the abdomen these conditions are not of much importance, but on the right, occurring as they do in connection with the great size of the liver, the large kidney occupies a lower position, and thus still further curtails the free space in the right flank. Viewed from the stand-point of the adult condition the rela-

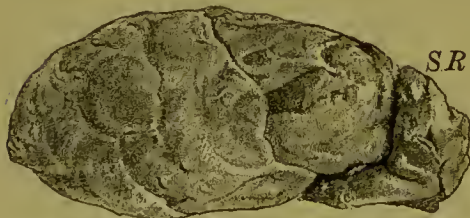
tions are, as has been pointed out by Henke, much more peculiar on the right than on the left. The kidney as a whole is lobulated, as you see in this specimen taken from an infant three days old. (Fig. 9.)

**Uric Acid Infarction.**—At birth a prenatal condition, represented by an orange or a light-red colored deposit near the pyramids in the straight tubules of the kidney, exists normally. This condition

is called the *uric acid infarction*, and the deposit consists of urate of ammonium, amorphous urates mixed with uric acid crystals, and some epithelial cells. (Plate III., 5, facing page 112.)

**Supra-Renal Capsules.**—The supra-renal capsules at birth quite cover and surmount the kidneys, as you will notice in this same lobulated kidney. (Fig. 9; the supra-renal capsule is indicated by *SR*.)

FIG. 9.



Lobulated kidney, natural size. Infant three days old. *SR* marks the supra-renal capsule. Warren Museum, Harvard University.



**STOMACH.**—Although it has long been known that in the adult stomach the greater part of the lesser curvature is vertical, and the long axis of the organ more nearly vertical than transverse, yet these facts have been slow in getting into the text-books and winning general recognition. It is probable that it has so long been taught that the stomach is placed transversely because when the abdomen is opened a triangular piece of the stomach comes into view, bounded on the left by the costal cartilages, on the right by the edge of the liver, and below by a part of its own greater curvature, which runs in a gentle curve from left to right. If this alone is seen it is very natural to assume that the stomach is placed transversely. The stomach at birth is remarkably small, and more tubular than in the adult, the fundus being but slightly developed. It is consequently even more vertical than in the adult, for it is the enlargement of the greater *cul-de-sac* that makes the obliquity of the axis pronounced.

This stomach (Fig. 10), taken from an infant three hours old, represents very well the organ at birth. Its capacity is 25 c.c. ( $\frac{5}{6}$  ounce). The weight of the infant was 2500 grammes ( $5\frac{1}{2}$  pounds). Although the weight was below that of the average infant at birth, the stomach was of about the average size, as was shown by its gastric capacity.

FIG. 10.



Stomach, natural size. Infant three hours old.  
Warren Museum, Harvard University.

**DUODENUM.**—The duodenum, in the adult, has of late usually been described as ring-shaped, but it generally presents pretty well marked angles, which divide it into a horizontal part running backward, a descending one along the right side of the spine, a transverse one crossing usually the third lumbar vertebra, and, finally, an ascending part along the left of the spinal column, which brings the end to about the same level as the beginning. Sometimes the last two parts are represented by a single one running obliquely upward to the left, in which case the duodenum is called V-shaped. The first horizontal portion is often somewhat dilated, and its walls are smooth, the valves beginning usually with the descending portion. The walls of the duodenum just beyond the pylorus are lined by a continuous layer of Brunner's glands, which extends through the first part, becoming more or less broken up towards the end. In the infant the shape of the duodenum, as shown



by plaster casts, is more nearly that of a ring, the two lower angles being rounded off. A constriction is often (perhaps usually) seen at the junction of the first and second parts, but Dwight's casts of the infant's duodenum do not show the folds, which are very striking in the casts taken from adults. That is to say, those of the infant show a few deep cuts into the cast instead of a great many near together. I have seen the folds,

FIG. 11.



Casts of duodenum taken from infant and adult, natural size.  
Warren Museum, Harvard University.

however, very richly developed in an infant of three weeks. In one case, that of a female six weeks old, Dwight found the duodenum of the V-shaped pattern, and, what is more remarkable, after it had passed the gall-bladder it was surrounded by peritoneum so as to swing freely as a loop suspended from the posterior abdominal wall. As to Brunner's glands, a few observations on young children have suggested that they were rather less developed relatively than in the adult, but I am by no means sure that this

is always the case. The duodenum has been compared to a trap, its ends being always higher than its middle, which is thus fitted to retain the fluid poured into it from the liver, the pancreas, and its own glands, besides that which it receives from the stomach.

The different points concerning the duodenum which I have just described are well shown in these casts taken from the adult and from the infant (Fig. 11), and must be borne in mind when we are considering the digestive functions of this important part of the intestinal tract.

The number and size of the folds and the shape of the duodenum in the adult would tend to delay the passage of its contents through it, and thus it also prevents the passage of gases from the small intestine upward into the stomach. If it be true, as I am inclined to think it is, that in the infant the system of folds is less developed, its passage would be relatively easy, which with a fluid diet seems desirable.

CÆCUM.—I should now like you to examine this specimen taken from an infant five days old. It represents the cæcum and appendix, and will aid you in understanding an important disease which we shall consider later,—*appendicitis*.

The cæcum is an interesting portion of the intestine at any age, and especially in the child. As is well known, the cæcum descends in the course of development from under the liver in the middle of the abdomen to the right iliac fossa, apparently passing first to the right and then descending; thus leaving behind it in its course the right half of the transverse colon and the whole of the ascending colon. It is needless to say that if it is possible for the cæcum to accomplish this journey it cannot be tightly bound by the peritoneum. On the contrary, the cæcum has a complete peritoneal coat and is perfectly free. At birth, and very possibly for a year or two afterwards, the cæcum has not, as a rule, reached its permanent position in the right iliac fossa. I have found it to measure three inches in length in an infant eleven weeks old.

INTESTINES.—From what we know of the development of the intestinal tract, which was at first merely a loop loosely attached to the posterior abdominal wall, it is natural to expect that in the infant and young child it should be less fixed than in adult life; and this is in fact the case. The difference is most striking in the large intestine, and is shown particularly in the cæcum, ascending colon, and sigmoid flexure. That this condition gives rise to dangers is evident, and I should say that there is a strong

FIG. 12.



Normal cæcum and appendix, natural size. Infant five days old. Warren Museum, Harvard University.



probability that the cases of infantile intussusception which occur with unusual frequency during the middle of the first year may arise from this anatomical peculiarity, and this makes a thorough knowledge of the anatomy of the cæcum important. The growth of the different parts of the intestine has been studied by Treves. He points out that in adults not only does the length of the intestine vary greatly, but also there is no constant relation between the small and large intestines. A long small intestine may be followed by a short large intestine, and *vice versa*, or both parts may exceed or fall short of the average. In the foetus at full term the length of the intestine, and especially of the colon, is singularly constant.

**Small Intestine.**—The average measurement of the small intestine is 287 cm. (9 feet 5 inches). The greatest variation that I have met with amounted to 61 cm. (about 2 feet).

**Large Intestine.**—The large intestine at birth, according to Treves, measures 56 cm. (about 1 foot 10 inches). So regular are these measurements that the greatest variation that I have met with in the colon was as little as 12.7 cm. (about 5 inches).

**Sigmoid Flexure.**—But little of the sigmoid flexure is found in the pelvis at birth.

**PELVIS.**—The small size of the infant's pelvis is to be noted also as the cause which, to a greater or less extent, forces the pelvic organs of later life into the abdomen during infancy. This condition is quite evident in this spine (Fig. 3, page 27) which I have already shown you.

**BLADDER.**—In the infant the bladder is practically wholly an abdominal organ. (This fact is well illustrated in Division II., Lecture III., Case 18, page 78.)

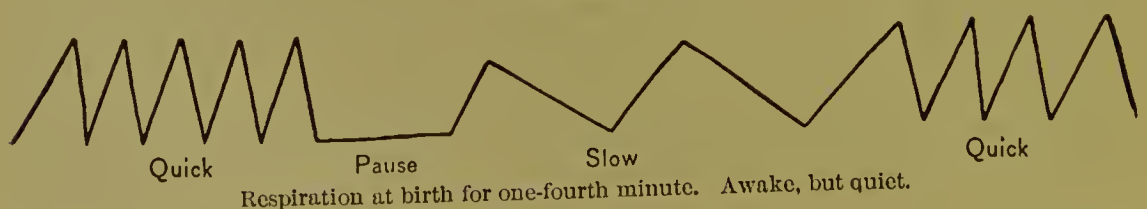
**UTERUS.**—At birth, part of the uterus is above the brim of the pelvis.

**TEMPERATURE.**—The temperature at birth is slightly higher than in the adult. It is about 37.2° C. (99° F.).

**PULSE.**—The pulse varies from 120 to 140 to the minute at birth, and it is at times irregular, especially during the first few hours.

**RESPIRATION.**—The respiration is about 45 to the minute, but it is of a very irregular type, and if you will closely watch the rise and fall of the thoracic walls in this infant (Case 3, page 26) you will see that the rhythm changes continually. The breathing is superficial, sometimes quick, and again dying away so as to be almost imperceptible. This condition, if occurring in an older child, would be a symptom of grave disease, but may be said to be normal at birth. The rate may be much quicker than 45, and I have frequently observed it as high as 60 or 70.

CHART 1.





**HEIGHT.**—The new-born infant's average height is in the male about 49.5 cm. ( $19\frac{3}{4}$  inches); in the female 48.5 cm. ( $19\frac{1}{4}$  inches).

**WEIGHT.**—The weight of the male infant is usually rather greater than that of the female. The average weight in a large number of cases showed that of the male to be 3250 grammes ( $7\frac{1}{7}$  pounds), while that of the female is 3150 grammes (7 pounds). Parker, in a careful examination of 170 infants at birth, of whom 89 were males and 81 females, found that the average weight of the males was 3520 grammes ( $7\frac{3}{4}$  pounds), while that of the females was 3290 grammes ( $7\frac{1}{4}$  pounds). There is, then, as I have said when speaking of Case 2, a certain amount of latitude to be accepted in this question of weights. The weight, however, has so close a connection with the vitality of the infant, that although we often see infants of light weight vigorous and thriving, and those of considerable weight failing to gain, yet as a general index of vitality the weight is a valuable starting-point and guide for our treatment. I would impress upon you that all rules and averages of this kind are not to be depended upon absolutely, but simply represent conditions which with other important factors aid us in solving the problem of vitality.

**VITALITY.**—In the early hours and days of existence it is the disturbance of the equilibrium of the infant's vitality which is especially to be feared and combated rather than the specific morbid processes of later childhood. We should therefore in each infant carefully determine the degree of inanition which we are called upon to deal with at this period of life, and I have personally found it useful to divide the weak and strong infants into groups according to their weights, allowing, as I have already explained to you, a somewhat lighter weight for girls than for boys.

This table (Table 2) will explain to you the meaning of what I have just said :

TABLE 2.  
*Relation of Weight to Vitality.*

Groups.	Weight.				Vitality.
1 . . . . .	2000 grammes	(about	$4\frac{1}{2}$ pounds)	. . . . .	Very low.
2 . . . . .	2500	"	$5\frac{1}{2}$	" . . . . .	Low.
3 . . . . .	3000	"	$6\frac{1}{2}$	" . . . . .	Fair.
4 . . . . .	3500	"	$7\frac{1}{2}$	" . . . . .	Normal.
5 . . . . .	4000	"	8	" . . . . .	High.
6 . . . . .	4500	"	9	" . . . . .	Very high.

**HANDS.**—At birth it is quite remarkable to find with what manifest strength the infant can grasp your finger. The nails are well formed.

**FEET.**—An important part of the infant's anatomy is the foot, and I take great pleasure in introducing for your study some original work which has been done by Dr. John Dane.

Here is an infant (Case 5) four days old. Dr. Dane has taken an impression of its feet, which shows very beautifully certain points about the instep at birth which are entirely different from, and in fact controvert, what has heretofore been taught on this subject. The practical importance of this truly scientific and laborious work I shall refer to in a later lecture.

Dr. Dane speaks of this infant and these impressions as follows :

“ It has been taught that the infant at term is flat-footed. The anatomy of the foot at this age allows it to bend up against the tibia from laxity of

FIG. 13.



Feet impressions of normal infant four days old. Arch intact.

the tendo Achillis, and it may seem flat from the stretching of the plantar fascia. The fact is that the arch is well formed, with its bones essentially in the adult position. Fat infants may, indeed, show the beginning of a pad

FIG. 14.



Flat foot impression, infant four days old. Arch broken down.

of adipose tissue under the arch, which becomes more marked as the infant develops, and in this way might easily be thought to be flat-footed.”

These points will be dealt with later in my lecture on Development.

Where flat foot really exists, the internal border of the impression shows an undulating appearance, and there is evidence of equal pressure over the whole of the tracing, as seen in the tracing taken from the foot of this infant also four days old. (Case 6.)

It is interesting and instructive to compare the different appearances which are presented in Fig. 13, showing the well-developed arch, and those in Fig. 14, representing the true flat foot.

You should also examine carefully these babies' feet which have produced these appearances.

**BONE MARROW.**—At birth, and in the early months of life, the marrow of the bones is red, as you see in a section of this bone taken from an infant seven months old. (Plate II., facing page 108.)

You will notice that the red color caused by the numerous injected blood-vessels is more intense at the central portion of the section of this bone than at the periphery or towards the ends. I merely show it to you as a normal and characteristic condition of early life, and one which may appear again at a later period in certain diseased conditions.

**FUNCTIONS.**—It is important for you to have a general idea of which of the functions are absent, partially developed, or developed at birth. The endeavor to call into use an undeveloped function, to tax a partly-developed function, or to overtax a developed one, is productive of great harm, and it has in my experience been the source of many conditions which, looked upon as diseases, are in reality but proofs that our anatomical and physiological knowledge has been deficient.

**VOICE.**—The normal infant at birth should present a developed voice, and should cry vigorously, thus assisting the lungs to expand and the new circulatory mechanism to be well started.

**SIGHT.**—Although the eye is, as I have already stated, anatomically developed and is sensitive to light, and although the visual perception is also possibly developed, yet there is still a lack of power to interpret the images perceived.

**HEARING.**—The auditory sensations appear to be rather dull during the first few days of life. This is possibly due to the absence of air from the tympanum and a tumid condition of the tympanic mucous membrane.

**TOUCH.**—The sense of touch is well developed.

**TASTE.**—The sense of taste is well developed.

**SMELL.**—The sense of smell is probably well developed ; but this is still a matter of dispute.

**SEBACEOUS GLANDS.**—The function of the sebaceous glands is fully developed at birth, as I have already described to you (page 23, Case 1).

**LACHRYMAL GLANDS.**—The secretion of the lachrymal glands is not developed at birth. The new-born infant does not shed tears, a fact of some clinical consequence in connection with the prognosis as to the convalescence of disease in the early days of life.

**SWEAT-GLANDS.**—The function of the sweat-glands is not developed at



birth as a rule, but according to my observations perspiration in certain individuals certainly occurs at a much earlier period than is usually supposed. I have seen an infant, premature at the seventh month, perspire freely one week after it was born, and in a number of individuals this function must exist in the early days of life.

**SALIVARY GLANDS.**—The salivary secretion, as has so clearly been pointed out by Foreheimer, is not fully established at birth, and consequently the mucous membrane of the mouth is comparatively dry, and, as you see, these infants' tongues (Cases 3 and 4) have a peculiar whitish color. This appearance is caused by the epithelium not being washed away by the saliva to the extent that it is after the later development of the function of the salivary glands. The amylolytic function of the saliva is very slightly present at birth, as has been shown by Zweifel and Korownin, who experimented with infusions of the salivary glands taken from young infants. The amylolytic action is indeed so insignificant that it merely shows us that the function of the salivary glands in the early months of existence is only partially developed and certainly should not be called into use.

**PANCREAS.**—The amylolytic action of the pancreatic secretion at birth is probably not all developed. The fat digestion is fairly developed at birth. The albuminoid digestion is fairly developed, but not fully.

**BILE.**—According to Foster, "the excretory functions of the liver are developed early, and at about the third month of intra-uterine life bile-pigment and bile-salts find their way into the intestine. A quantity of bile secreted during intra-uterine life accumulates in the intestine, especially in the rectum, and forms, together with the smaller secretion of the rest of the canal and some desquamated epithelium, the meconium. The distinct formation of bile is an indication that the products of foetal metabolism are no longer wholly carried off by the maternal circulation, and that to the excretory function of the liver are now added those of the skin and kidney."

**BLOOD.**—It is impossible by the methods at present known to determine exactly the total amount of blood in either infant or adult, but, while the adult's blood is approximately about one-thirteenth of the entire weight of the body, the infant's is represented by only one-fifteenth. The blood is rather more dense than in the adult, and contains a large amount of hæmoglobin. It is not rich in fibrin, and does not coagulate perfectly, a fact to be remembered when we are considering the hemorrhagic disease and hæmophilia of the new-born. Soon after birth some of the globules are still found to have nuclei, but these soon disappear.

**RED CORPUSCLES.**—The proportion of the red globules at birth is about 5,900,000 to the cubic centimetre.

**WHITE CORPUSCLES.**—The number of white corpuscles is about three times as numerous as in the adult's blood, and about 21,000 to the cubic centimetre.

**LYMPHATIC SYSTEM.**—The lymphatic system is very active at birth.

**URINE.**—The amount of urine secreted during the first two days of life is very small, and its specific gravity is about 1010. The kidney shows the condition of the uric acid infarction, and it is not infrequent to find the napkins stained with a uric acid deposit, such as you see represented on this napkin (Plate III., 1, facing page 112).

**INTESTINAL DISCHARGES.**—Unless a discharge of the contents of the intestine has taken place during the delivery, as is so often seen in breech presentations, it occurs immediately or very soon after birth, as you have already seen in the first case which I presented to your inspection this morning.

**MECONIUM.**—This discharge which first comes from the intestine is called the *meconium*. It is inodorous, viscid, slightly acid, and of a brownish-black color, such as you see on this napkin taken from an infant a few hours old (Plate III., 2, facing page 112). The meconium contains mucus, epithelium from the intestinal mucous membrane, epidermal cells, hairs, and fat-drops from the vernix caseosa which have been swallowed with the amniotic fluid from time to time. It also, according to Vierordt, contains the constituents of the bile, and its total amount is from sixty to ninety grammes (two to three ounces), of which the solid part forms about twenty per cent. The intestinal contents at birth are sterile.

## DIVISION II.

### NORMAL DEVELOPMENT.

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#### LECTURE III.

##### SPINE.—NECK.—HEAD.—THORAX.

WE have considered in a general and practical way the conditions which exist in the infant at term. The data which we have acquired in this consideration constitute only a part of the alphabet which we are endeavoring to master.

In order to differentiate normal from abnormal conditions in the growing infant and child, we must now examine the different stages of development which correspond to the various ages, and thus complete our anatomical and physiological alphabet.

You remember the condition of the cord in Case 2 (Frontispiece), which I showed you at the previous lecture. You see that in this infant (Case 7),

nine days old, the cord has fallen off. This occurred twenty-four hours ago.

CASE 7.



Infant nine days old. Natural condition of umbilicus after recent separation of cord.

By a process of disintegration the cord at about the seventh or eighth day separates from the living tissues around the umbilicus. A certain amount of bleeding may take place at the point of separation, but

this is usually very slight: it may, however, be the beginning of one of the most serious forms of disease in the new-born, *umbilical hemorrhage*.

You will notice how the umbilical depression is well marked even when the infant cries, and you will thus distinguish this normal anatomical condition following the separation of the cord, from the umbilical prominence which I shall show you later as representing cases of umbilical hernia.



**SPINE.**—The time of consolidation of the bodies of the vertebræ is not accurately known, but it may be roughly stated to begin in the third year, and, probably, to end in the seventh. A large number of observations must still be made before the march of ossification can be determined. The statements regarding this point are copied from one book to another, and are often quite imaginary.

The union of these chief centres to form the bodies of the vertebræ begins in the lumbar region, and is first completed there. This union, however, had not taken place in the dorsal and cervical region of the child said to be three years old, used for "The Frozen Sections of a Child" (Dwight). On the other hand, in a girl of five or six years, figured by Symington, the process was found to be hardly finished in the lumbar region, and higher up it seemed about the same as in the younger child.

The process of union of the laminae is probably completed in the first few months of life.

**LENGTH.**—Aeby gives the following table for the adult spine, showing both the absolute and the relative length of the cervical, dorsal, and lumbar regions (the measurements are in millimetres):

TABLE 3.

<i>Absolute.</i>				
	Cervical.		Dorsal.	Lumbar.
Female . . . . .	122.9	+	265.8	+ 190.3 = 579
Male . . . . .	129.9	+	273.4	+ 184.1 = 587.4
<i>Relative.</i>				
	Cervical.		Dorsal.	Lumbar.
Female . . . . .	21.12		45.7	32.8
Male . . . . .	22.1		46.6	31.3

Cunningham obtained strikingly similar proportions in an average of the measurements of six males and five females:

TABLE 4.

<i>Relative.</i>				
	Cervical.		Dorsal.	Lumbar.
Female . . . . .	21.6		45.8	32.8
Male . . . . .	21.8		46.5	31.7

Aeby gives the following table of the average of five infants, and Cunningham a table of three:

TABLE 5.

<i>Relative.</i>				
	Cervical.		Dorsal.	Lumbar.
Aeby . . . . .	25.6		47.5	26.8
Cunningham . . . . .	25.1		48.5	26.4

The following table shows the results of the measurements of the spines of children by various authorities, as well as by Professor Dwight. The table requires no elucidation, but I shall call attention to the remarkable uniformity of observations by different men in spite of the errors incident

to the personal equation of the measurements and the individual variation which doubtless exists. The relative length of the dorsal (more properly the thoracic) region throughout the table is somewhat greater than that of the adult; still it appears that after the age of five or six the proportions are not far from those of after-life.

TABLE 6.  
*Length of Spine to Sacrum.*

ABSOLUTE LENGTH, IN MILLIMETRES.						RELATIVE LENGTH. Total = 100.		
Age.	Observer.	Cervical.	Dorsal.	Lumbar.	Total.	Cervical.	Dorsal.	Lumbar.
3 months . .	Rasanel . .	50	100	58	208	24	48.1	27.9
6 months . .	Aeby . . .	52.5	103	60	215.5	24.3	47.5	27.8
6 months . .	Aeby . . .	53.5	107	61	221.5	24.1	48.6	27.5
10 months . .	Dwight . .	61	125	77	263	23.2	47.5	29.2
2 years, boy .	Rasanel . .	70	140	90	300	23.3	46.7	30
2 years, boy .	Aeby . . .	79.5	153.5	98	331	24	46.4	29.6
3 years, girl .	Dwight . .	78	162	101	341	22.9	47.5	29.6
4 years, girl .	Aeby . . .	79.9	162	103.3	345.2	23.1	46.9	29.9
5 years, boy .	Symington.	80	170	104	354	22.5	48	29.4
5 years, boy .	Rasanel . .	80	180	135	395	20.3	45.6	34.2
6 years, boy .	Symington.	80	175	106	361	22.2	48.5	29.3
9 years, girl .	Rasanel . .	85	195	150	430	19.8	45.4	34.9
11 years, boy .	Aeby . . .	91	218.7	153.5	463.2	19.7	47.2	33.1
13 years, girl .	Symington.	95	220	136	451	21.5	48.7	29.1
16 years, girl .	Aeby . . .	100	221.9	151	472.8	21.1	46.9	31.9
16 years, girl .	Aeby . . .	107.5	229.5	152.5	489.5	21.9	46.9	31.1
17 years, girl .	Dwight . .	113	250	161	524	21.5	47.7	30.7

The figures to the left of the double line in the table express the absolute length of the different portions of the spine, in millimetres.

Those to the right are the same figures reduced to terms of 100, within a fraction.

**FLEXIBILITY.**—I have already shown you how very flexible the spine is at birth. This flexibility becomes less as the infant grows older.

In the cadaver of a female child of ten months it was found that extension was no longer so free as in the earlier months, and it required a strong pull to make the head touch the nates. The dorsal region, however, could still be made concave behind. Flexion was free, especially in the lower part of the lumbar region, where the pelvis and legs could be swung forward. On rotation the head could be turned through an arc of  $90^\circ$  without using the joint between the atlas and the axis. In a male child of the same age, extension of the spine was found to be still more restricted.

**CURVES.**—In the last lecture I explained to you that at birth there were no natural curves in the infant's spine.

An important factor in the production of the curves in the cervical and dorsal regions is probably the pull of the muscles, as will be presently described. The dorsal curve seems to be a permanent condition of a part of the general curve of the body. As soon as the muscles of the back of

the neck contract so as to raise the head from the chest, the front of the neck will be convex, and finally this becomes the habitual position. As Symington has pointed out, however, this cervical curve is never, properly speaking, consolidated, for it can always be obliterated by a change of the position of the head. The production of the lumbar curve is more complicated. If an infant be laid on its back on a table, the knees are raised and fall apart; if they are brought together and forcibly pressed down, the lumbar region will spring up from the table and the beginning of a lumbar curve will appear. It is supposed that this is caused by the shortness of the ilio-femoral ligaments, which, when the thighs are brought down, flex the pelvis, throwing the promontory of the sacrum forward. As the child begins to stand, the body is inclined forward, and when this is straightened by the muscles of the back the same thing occurs, for of course it is unimportant whether the legs are extended on the trunk or the trunk on the legs. The credit of this explanation has generally been given to Ballandin, but it appears to belong to Cleland.

This curve, therefore, is first observed when the child is one or two years old, but it is not until some time later that it is habitually present, and I am not prepared to say when it actually occurs. It can be obliterated up to adult life, and I rather suspect in many cases even later. The influence of the muscular system is important not only in forming two of the spinal curves, but in maintaining them afterwards. I am convinced that the greater rigidity of the body that is found after puberty is largely dependent on the muscles. The tonicity of the muscles has a great deal to do with retaining the curves of the spine and with limiting its movements. Many of the feats of contortionists are due to this power of relaxing antagonistic muscles, and, as a rule, we find in children a greater proportion of muscle to tendon than in adults. It is, therefore, due more to the want of power to relax the muscles than to the lack of a peculiar formation of the bones and joints that children cannot perform many of these feats. The importance of the muscles in distortions is very great. The spine of the child is flexible in many ways, and the unruly pull of a muscle may easily produce a lasting effect. Not only should the muscles have strength enough to maintain the figure without conscious effort, but their action should be symmetrical on both sides, and should also have a proper relative force before and behind (Case 47, Lecture V., page 145). The importance of light gymnastic exercises is now so generally understood that I need do no more than allude to it. What, however, is of great practical clinical interest in connection with the anatomical and physiological facts concerning the spine, spoken of above, is the way in which they distinctly emphasize the value of this preliminary knowledge in the study of preventive medicine. This point will be spoken of in a later lecture.

What I have just told you regarding the curves of the spine at different ages will, I think, be better understood and remembered if you will for a moment again look at these lines (Diagram 2, Lecture II., page 28), repre-



senting the curves of the infant's spine at birth and also at different ages up to the period of standing.

These lines were made at my suggestion by Professor Dwight.

**SURFACE ANATOMY.**—The surface anatomy of the spine is of much importance in the adult, and must not be overlooked in the child, where it presents striking differences. In the first place, a prominent feature in the adult, especially in a muscular male, is that a depression is found wherever the skeleton shows a prominence, owing to the development of the muscles. Thus, the skeleton shows a ridge of spines in the middle line of the back, with a valley on either side; but during life normally we have a median furrow between two swellings formed by muscular masses. In the infant this is not the case (except perhaps in the neck), but the back is rounded; later it is more flattened, and the line of the spinous processes, far from being in a depression, is rather prominent. This is the more remarkable as when we examine the dissected spine from behind we find it very different from that of the adult. In the infant the laminae look more directly backward, and their presence in the median line is marked by knobs and ridges very different from the spine of the adult. Up to a year, or perhaps eighteen months, the proportions are not very different, but the spine at three shows that a great change has occurred, for the spinal processes now stand out in a prominent row, and present very nearly adult proportions. The greatest difference is in the dorsal spines, which are relatively broader at their points and less gracefully drawn out than in the adult. The bodies of the vertebrae still remain less deep, and therefore the relative positions of the spines and bodies show less difference than might be expected. For example, the tip of the spinous process of the seventh dorsal vertebra in the adult reaches down to the lower border of the body of the eighth vertebra, or the head of the ninth rib. At three it goes very nearly as far, though its shape is not the same. At six or seven the spine has made still further progress towards the adult proportions. By the end of the second year the back of the living child is not only flatter and broader (the results of continuous changes), but there is the appearance of the median furrow, and at five or six the differences in this respect from the adult are not marked. It is barely possible to count the spines in the infant and young child, and at three and four years it is not very easy, though less difficult than in the adult.

**PROMINENT SPINOUS PROCESSES.**—A source of error is the adjective "prominens" applied to the seventh cervical vertebra, which naturally suggests that its spine is the most prominent in the back of the neck. This is not usually the case. The first dorsal spine is the most prominent in that region. The atlas has no spine at all; the spinous process of the axis is thick and prominent, perhaps relatively less marked in the child than in the adult; the third and fourth spines are very small; the fifth is not much larger; but the sixth projects more, and the seventh is said to be usually the first prominent one. He who trusts, however, to this rule is very liable to error, for the relative size of the lower cervical spines varies considerably.

The sixth may be the first to assume prominence, and the seventh cervical and first dorsal may exceed it but little. It is easier to examine a child of three years and upward than an adult, on account of the greater softness of the tissues, which allows us to feel more deeply in through the furrow of the neck, and, having recognized the axis by alternately flexing and extending the head, to count the cervical vertebræ in order. If it should be in any case absolutely impossible to feel the third and the fourth, it is better to allow a certain space for them and to call the next one the fifth than to assume arbitrarily that a certain one is the seventh. Confirmatory evidence may be gained from the height of the sternum, to which point I shall return later.

**NECK.**—I have already referred to the peculiarities of the infant's neck at birth. (Lecture II., page 30.)

**CRICOID CARTILAGE.**—Symington states that in two children respectively five and six years old the lower border of the cricoid cartilage was found to be at the lower border of the fifth or at the top of the sixth vertebra. I do not quote his observations at intermediate ages, as the position of the head in these measurements varied a good deal. In a girl of thirteen he found that it had reached the adult position; that is, about on a level with the top of the seventh vertebra.

**EPIGLOTTIS.**—Symington found also that the top of the epiglottis descends during growth from about the level of the lower border of the atlas to the middle of the third cervical vertebra, or even lower.

**LARYNX.**—This high position of the larynx would imply a greater part of the trachea relatively above the sternum, but this is neutralized by the high position of the latter. The amount of fat in the neck makes the trachea less accessible. The greater distance of the trachea from the surface, as it descends, and the greater danger of meeting the large arteries and veins above the sternum in the child, are points of anatomy so well known in connection with tracheotomy that it seems hardly worth while to insist on them.

Tillaux made a series of measurements of the distances from the sternum to the hyoid, the thyroid, and the cricoid, in men, women, and children of both sexes.

**DISTANCE FROM STERNUM TO CRICOID.**—I give a condensation of his statements of the distance from the sternum to the cricoid, as the most practical. In twelve women it ranged from five and a half to seven and a half centimetres, the average being six and a half centimetres. In men the variation was greater, ranging from four and a half to eight and a half, but the average was precisely the same. Among the men was a boy of fifteen and a half years, in whom the distance was seven and a half centimetres. Tillaux measured thirty-one children, nineteen girls and twelve boys, ranging from two years up to ten and a half. There seems no reason for keeping the sexes distinct, and I further condense the table by giving the average in the cases of several of the same age, with the following result:

TABLE 7.  
*Relation of Cricoid to Sternum.*

Years.	Distance from Cricoid to Sternum.	
2½	3.5	centimetres.
3	4	"
3½	4	"
4	3.8	"
4½	4	"
5	4.5	"
6	4.9	"
6½	5.5	"
7	5.1	"
7½	4.5	"
8	5	"
8½	5.25	"
9	5.25	"
9½	6.5	"
10	6.5	"
10½	6.5	"

It seems rather remarkable that at ten years the distance should be as great as in the adult, but this may be accounted for by the subsequent descent of the larynx, and also, probably, by its proportionate enlargement (at least in the male) about puberty.

The peculiarities of the relations of the top of the larynx and pharynx to the spine in the young child are points of much practical importance, to which I shall return. The changes which occur during growth depend largely on changes in the base of the skull, and on the downward growth of the jaws, which will be considered presently.

**HEAD.—CIRCUMFERENCE.**—The measurement of the circumference of the head increases very rapidly, and in early childhood almost attains that of the average adult's head. We must therefore be careful about giving an opinion that the head is relatively large for the age of the child. I have myself measured over one hundred children of different ages in both hospital and private practice in order to get a general idea of the circumference of the head and its proportion to that of the thorax. The number is, of course, too small to make any precise average deductions from, but in a general way I have found these measurements useful.

**CIRCUMFERENCE RELATIVE TO THORAX.**—Thus, I have found that while at birth the head usually has a circumference of 33 cm. (13 inches), the thorax, measuring over the nipples and just under the angles of the scapulæ, has a circumference of 1 or 2 cm. ( $\frac{1}{2}$  to  $\frac{3}{4}$  inch) less. A change in these measurements and proportions soon takes place. In the fourth to fifth week, for instance, and extending into the seventh and eighth weeks, 38 cm. (15 inches) for the head and 35 to 36 cm. (14 to 14½ inches) for the thorax I have found to be not uncommon figures. In like manner at five or six months 42 to 45 cm. (16½ to 18 inches) for the head and 41 to 42 cm. (16¼ to 16½ inches) for the thorax are figures occurring in my measurements. At nine months it is not uncommon to find 45.5 cm. (18 inches) for the head



and 43 cm. (17 inches) for the thorax. At the end of the first year in a number of cases I found that the circumference of the thorax had reached and even surpassed that of the head, as seen in this infant (Case 8), where the head is 45.5 cm. (18 inches) and the thorax 47.5 cm. ( $18\frac{3}{4}$  inches). In exceptional cases the thorax surpasses the head at a much earlier period; and I have even seen it to be a trifle larger at birth, but this is unusual. I have recently measured a healthy infant whose weight at birth was 3800 grammes ( $8\frac{1}{2}$  pounds), whose head measured 34 cm. ( $13\frac{1}{2}$  inches) and whose thorax also measured 34 cm. ( $13\frac{1}{2}$  inches). In the second year I find very varying figures, and the head often still remains larger than the thorax. Thus, in these two infants which I shall now show you, one (Case 9), who is eighteen months old, has a head measuring 49 cm. ( $19\frac{1}{2}$  inches) in circumference, and a thorax 46 cm. ( $18\frac{1}{4}$  inches), while the other (Case 10), also eighteen months old, has a head measuring 47 cm. ( $18\frac{1}{2}$  inches), and a thorax 45 cm. ( $17\frac{3}{4}$  inches). Here is another infant (Case 11), twenty-one months old, who has a head 51 cm. ( $20\frac{1}{4}$  inches) and a thorax 50 cm. ( $19\frac{3}{4}$  inches) in circumference. My measurements have been taken mostly from boys. The girls that I have measured seem proportionately for the same age to show smaller measurements of the thorax, and to have the thorax overtaking in its circumference the head at a rather later date than is the case with boys. By the second year the thorax has almost always overtaken and surpassed the head. I will now show you some measurements of the head and thorax from two to thirteen years which I happen to find in my notes. They were all males, and it must be remembered that they are not exact averages for a large number of cases, but merely measurements which I found corresponded in a number of children of these different ages. I present them as showing especially how it becomes noticeable when the circumference of the head is taken at random in your general practice, that after the second year the measurements of the head correspond pretty closely, and depend upon the individual rather than upon the age. The thorax, on the contrary, seems to increase year by year.

TABLE 8.  
*Circumferences of Head and Thorax from Two to Thirteen Years.*

Years.	Males.	
	Head.	Thorax.
2 . . . . .	48 cm. (19 inches)	51 cm. ( $20\frac{1}{8}$ inches).
3 . . . . .	51 cm. ( $20\frac{1}{8}$ inches)	55 cm. ( $21\frac{3}{4}$ inches).
4 . . . . .	53 cm. (21 inches)	54 cm. ( $21\frac{1}{4}$ inches).
5 . . . . .	53 cm. (21 inches)	54 cm. ( $21\frac{3}{4}$ inches).
6 . . . . .	52 cm. ( $20\frac{1}{2}$ inches)	55 cm. ( $21\frac{3}{4}$ inches).
7 . . . . .	54 cm. ( $21\frac{1}{4}$ inches)	54 cm. ( $21\frac{1}{4}$ inches).
8 . . . . .	53 cm. (21 inches)	59 cm. ( $23\frac{1}{8}$ inches).
9 . . . . .	54 cm. ( $21\frac{1}{4}$ inches)	61 cm. (24 inches).
10 . . . . .	53 cm. (21 inches)	62 cm. ( $24\frac{1}{2}$ inches).
11 . . . . .	56 cm. ( $22\frac{1}{8}$ inches)	63 cm. ( $24\frac{3}{4}$ inches).
12 . . . . .	53.5 cm. ( $21\frac{1}{8}$ inches)	63 cm. ( $24\frac{3}{4}$ inches).
13 . . . . .	54 cm. ( $21\frac{1}{4}$ inches)	66 cm. (26 inches).

This series of circles, representing the circumferences of the head, thorax, and abdomen, will, I think, show you at a glance what you may expect as to the relations of these parts of the child in the first year. They represent the average of a number of actual cases which I have had an opportunity of closely watching in their nurseries from birth to one year.

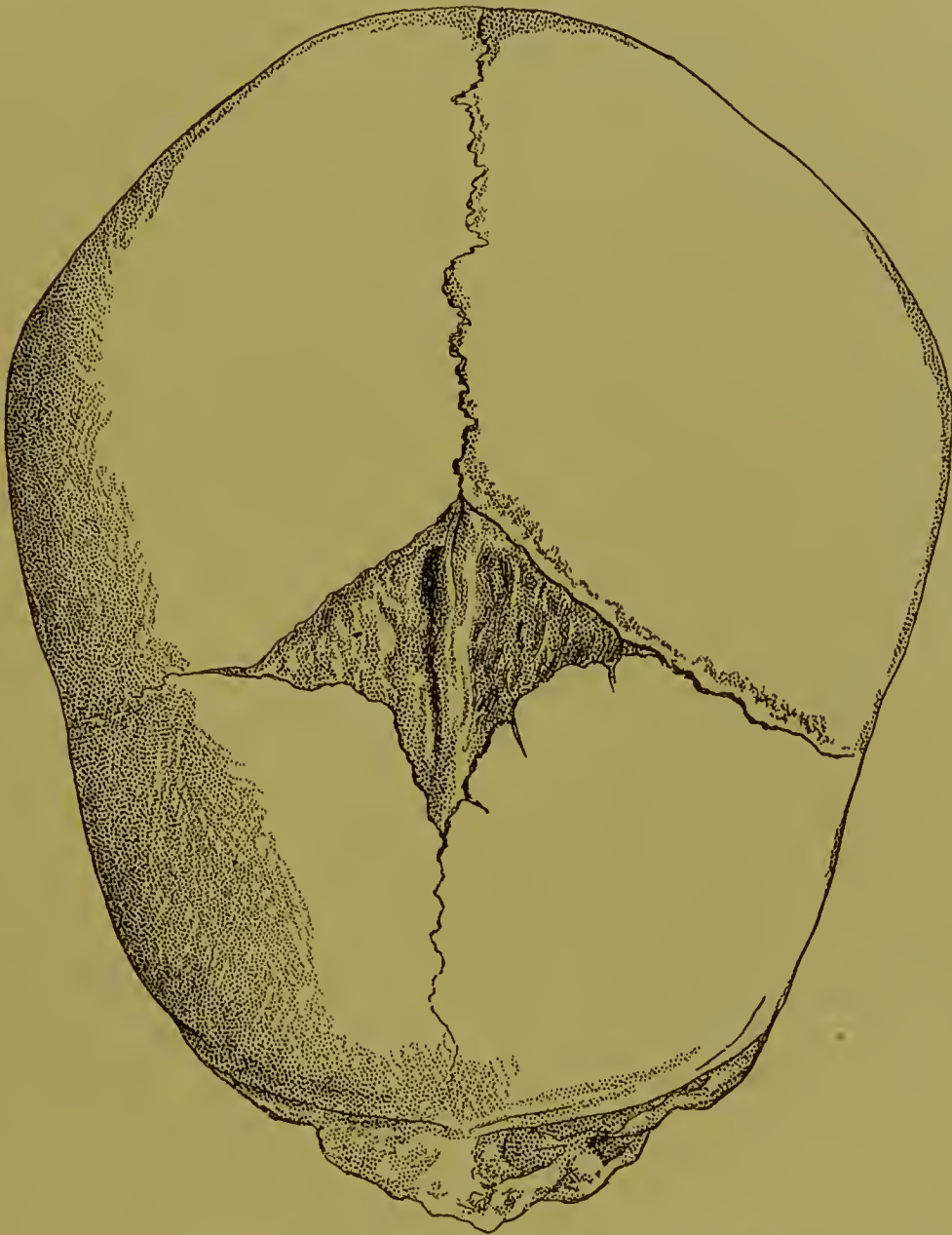


The general idea which you can get from these diagrams will, I know, help you in your nursery practice, where you have to determine in a few minutes whether an infant is fairly developed. No especial significance need be given to the circumference of the abdomen in this connection beyond what I have previously said concerning the liver, as its measurements, of

course, vary very much normally according to the degree of distention present.

The fact that I have represented the head and thorax equal in the middle of the year, and the thorax larger than the head at the end of the year, does not establish any rule for these periods, as you see from what I have previously said. The diagram merely in a very simple way enuneiates

FIG. 15.



Infant skull, natural size. Anterior fontanelle  $4 \times 3$  cm.  
Warren Museum, Harvard University.

that, although there is great activity shown in the growth of the head, this activity is still greater in regard to the thorax.

**FONTANELLES.**—The *posterior fontanelle*, although ordinarily quite perceptible at birth, soon disappears, either from overlapping of the bone or from a permanent closure, and is usually imperceptible by the sixth week.

The *anterior fontanelle*, so far as my observation is concerned, seems to grow larger as the infant grows older, up to about the ninth month; this



point is, however, disputed, and the increase may be apparent rather than real. It also seems to remain stationary, or almost so, from the ninth to the twelfth month, and then decreases slowly. It should be closed by the nineteenth to the twentieth month.

When we study the disease rhachitis you will understand how important is a knowledge of the closure of the fontanelles.

This skull (Fig. 15, page 63) of an infant in the early weeks of life shows very well the increase of the diameter of the anterior fontanelle. While, as you see, in this skeleton of the infant at term (Fig. 33, page 118) the measurements were  $3 \times 2$  cm. ( $1\frac{1}{4} \times \frac{7}{8}$  inches), this fontanelle measures  $4 \times 3$  cm. ( $1\frac{3}{4} \times 1\frac{1}{4}$  inches).

FACE AND CRANIUM.—As I stated in a previous lecture (Lecture II., page 31), the proportion of the face to the cranium in infancy is as 1 to 8. Froriep has also made observations on this point in older children, and finds the following proportions :

TABLE 9.

<i>Proportions of Face to Cranium.</i>	
Age.	Face. Cranium.
Early infancy . . . . .	1 to 8
2 years . . . . .	1 to 6
5 years . . . . .	1 to 4
10 years . . . . .	1 to 3
Adult female . . . . .	1 to $2\frac{1}{2}$
Adult male . . . . .	1 to 2

The small size of the facial portion of the skull in infancy and early childhood is well shown in these skulls (Fig. 16, page 67) of the infant at birth and at three years, and also in these skeletons (Figs. 33 and 34, page 118) of the infant at birth and at nineteen months.

As the child develops, very important changes occur in the base of the skull, one of the greatest of which is the downward growth of the face. Originally the base of the skull is practically flat. The sudden rise of the basilar process in front of the foramen magnum, the angle formed with it by the body of the sphenoid, and then the sharp descent of the vomer, are adult characteristics of which at birth there is little trace. The nasal cavity is shallow and relatively long, the posterior nares are small, and the vomer approaches the horizontal. The naso-pharynx has, therefore, very little height. The alveolar processes are still undeveloped, and the ramus of the lower jaw is very oblique, so that the cavity of the mouth is small. As a consequence, the larynx is, as we have seen, placed very high up. One of the chief causes of its descent is the downward growth of the face.

BRAIN.—Much credit is due to Dr. George McClellan, of Philadelphia, for his careful and laborious work, extending over many years, on the anatomy of the different periods of life. His careful dissection of the infant's brain is very valuable for reference, and I wish to acknowledge the use which I have made of it. I desire also to express my appreciation of the anatomical work on infants done by Dr. J. W. Ballantyne, of Edinburgh.

**Dura Mater.**—An important anatomical condition in connection with the brains of young subjects is that the dura mater is adherent to the skull, and thus prevents the collection of extravasations between it and the bone.

**Subarachnoid Space.**—The subarachnoid space usually contains a larger amount of fluid in childhood than in later life.

**Growth.**—I have already mentioned the large proportionate size of the brain at birth (Lecture II., page 37).

Up to the seventh year the brain shows an active growth, and after that year increases slowly in weight. The convolutions are not fully developed at birth, and are gradually perfected as the child grows older. The various centres of the brain which gradually become so highly developed in later childhood have but little action, so far as we can judge, at birth and in the early weeks.

**EAR.**—The osseous meatus is not developed until about the fourth year. In introducing the aural speculum under four years of age, you should therefore draw the ear forward and downward instead of upward and backward as in older children and adults, or the canal will be bent on itself.

**PETRO-SQUAMOSAL SUTURE.**—The time at which the *petro-squamosal suture* closes is not at present known.

**NASO-PHARYNX.**—Now, if you will again examine these fusible metal casts (Fig. 5, page 33), you will see, as I have already pointed out to you, in this one taken from an infant, that although the inferior turbinate projects slightly into the cavity of the nose, yet there is but a very minute expansion below it and none passing up behind it.

According to Disse, it is this part which shows the greatest growth. It begins to increase in height directly after birth, and goes on pretty rapidly till the beginning of dentition, when it is slow till the second year is completed. After the first set of teeth are cut, the growth is rapid till the end of the seventh year. The increase in breadth occurs in the last-mentioned period, which also is the time in which the growth of the olfactory portion is most marked. Disse states that the posterior opening doubles its size in six months, remains stationary till the end of the second year, and then increases again.

Professor Dwight's measurements on bones are as follows :

TABLE 10.

Age.	Height of Posterior Nares.	Breadth between Ptery- goid Processes at Hard Palate.
About birth . . . . .	6 to 7 millimetres.	9 millimetres.
From 12 to 16 months . . . . .	13       “	16       “
“ 12 to 18       “ . . . . .	15       “	16       “
“ 14 to 20       “ . . . . .	14       “	17       “
“ 18 months to 3 years . . . . .	15       “	21       “
“ 2 to 4 years . . . . .	15       “	20       “
About 6 years . . . . .	16       “	20       “
7 or 8 years . . . . .	20       “	22       “
About 11 years . . . . .	18       “	22       “
17 years, female . . . . .	22       “	20       “

We may compare with the above, ten measurements which Professor Dwight has made on adult skulls. I give both the average and the extremes of variation.

TABLE 11.

Ten Adults.	Height of Posterior Nares.	Breadth between Pterygoid Processes at Hard Palate.
Average . . . . .	28.4 millimetres.	27.7 millimetres.
Extreme . . . . .	28 and 31 “	24 and 31 “

These figures show that the height does not gain the predominance until adult age. At the end of the seventh month the nasal cavity approaches the adult shape, though it seems broad in proportion, and has not, of course, attained its full size. Merkol has shown that in later adolescence the growth of the respiratory portion takes place chiefly in the middle meatus. In infancy the posterior border of the vomer is very oblique. With the growth downward of the jaw this obliquity is much diminished at the age of seven or eight years.

**Eustachian Tubes.**—The course of the Eustachian tube and the position of its opening undergo changes corresponding to the development of the nasal cavity. As I have already told you, at birth the tube is horizontal, or nearly so. In the adult the cartilaginous portion slants downward. Nevertheless, the opening of the tube is opposite a higher part of the nose in the adult than in the child. In the fœtus the opening is below the level of the hard palate, which it reaches at birth. Up to the ninth month after birth, according to Disse, there is but little change. After that time, however, the opening is distinctly higher than the floor of the nasal cavities. At four years, Kunkel found it to be three or four millimetres higher. In the adult it is opposite the end of the inferior turbinate bone.

**Pharyngeal Tonsil.**—The pharyngeal tonsil increases after birth, and by the end of the first year has a length of eighteen millimetres.

Professor Dwight tells me that he failed to satisfy himself of the presence of anything that could be called a pharyngeal tonsil in the head of an ill-nourished child of four weeks which he recently divided in the median line. There is probably much variation. Dr. Dwight has a beautiful specimen of one in a similar section of the head of a child of three years or less. It has a length of about twenty millimetres, and narrows most strikingly the passage from the nose to the lower part of the pharynx.

From the tip of the uvula to the top of the epiglottis Braune found the distance to be twelve millimetres in the median section of an adult female. In Symington's section of a boy of about six years it is five millimetres. In a section of a head of three years or less it is not over two millimetres, and in another of four weeks we find that had the mouth been closed when the head was frozen, the parts would probably have been in contact. The precise progress of the changes from the infantile condition is still to be observed. I may say, however, from the sections at the Harvard Medical School, from Symington's plates of children of six and thirteen years, and from other



measurements of children, that the change in the first two or three years is very great, and that the pharynx of older children resembles more that of the adult than that of the infant. Indeed, at four weeks we find the tip of the epiglottis on a level with the lower part of the odontoid process, but, of course, by opening the mouth and depressing the soft parts space may be gained.

**HARD PALATE.**—In a child of three years or less the line of the hard palate strikes about the middle of the basi-occipital bone. It would hardly be possible, without passing the finger round the soft palate, to feel much higher than the arch of the atlas. The base of the odontoid process would be under the mucous membrane seen at the back of the throat through the open mouth. The tip of the epiglottis is at the junction of the odontoid with the body of the axis. I doubt if more than the very top of the third vertebra could be satisfactorily explored. At six and at thirteen (Symington's plates) I find that the line of the hard palate has about the adult direction,—that is, it strikes about the top of the atlas or the basilar process near its beginning. In both the finger could probably examine the vertebræ from the first to the fourth inclusive. The atlas, however, would be reached with much more difficulty in the older than in the younger subject, as the relations of the soft palate are more nearly those of the adult.

**MOUTH.**—As the infant grows older the mouth becomes an organ more adapted for certain uses beyond that of a mere means of entry for the food to the stomach.

**MAXILLARY BONES.**—The ossification of the maxillary bones begins early, progresses slowly, and, together with the final formation of the jaw, is completed at puberty. These skulls (Fig. 16), one of an infant born at term, the other of a child



Skulls showing development of ramus at birth and at three years.  
Warren Museum, Harvard University.

three years old, represent the characteristic incomplete development of the ramus of the inferior maxillary bone in the early weeks and months of life, and its almost complete development at three years.

The chief characteristic, as you see, is the oblique angle which the ramus makes with the body of the bone at birth, and this becomes more evident when you compare it with the jaw at three years. You will observe the much greater proportion of the ramus to the body of the bone at three years, and the nearer approach to a right angle where they join.

**Teeth.**—Fleischmann's work on this subject is worthy of especial attention, as it will elucidate many points of interest when we come to speak in a later lecture of diseases of the mouth and difficult dentition. His description of the development of the teeth, and McClellan's description, which can be found in the first volume of Keating's "Cyclopædia of the Diseases of Children," need hardly be mentioned in detail, but they provide us with facts which will in a measure explain certain symptoms of clinical interest during the period of dentition. The development of the first set of teeth begins at about the seventh week of intra-uterine life, and, progressing slowly, is completed about the end of infancy. At birth the twenty embryo teeth, ten in each jaw, are so enclosed in the alveolar processes that nothing but the smooth mucous membrane is apparent on the gums above. Below, they are connected with the branches of the inferior dental nerve (an important clinical fact to be remembered) through openings at the bottom of the alveolar processes. When calcification of the neck of the tooth begins, elongation also takes place, and, as the tooth is enclosed in bony walls below and on the sides, it gradually grows through the point of least resistance, namely, the gum, which covers the top of the alveolar processes. The continued pressure gradually causes atrophy of the mucous membrane, and the crown of the tooth appears on the edge of the gums. The various teeth come through the gum at times which are regulated according to their development, that is, at times corresponding to the calcification of their roots and consequent elongation. This process usually takes place in groups and with considerable regularity in the average normal infant. Variations both as to the order in which the teeth appear and in the time of their appearance are so common that it seems hardly practicable to have set rules designating these times. The experience of different physicians seems to differ, but all practically are guided by very general rules.

An infant may be born with one or more teeth, as you see in this infant fourteen days old, which has just been brought to the clinic to be operated on by Dr. Augustus Thorndike, who kindly presents the case for your inspection. You see that it has an everted intermaxillary bone, on the outer side of which is the left middle incisor, which evidently came through the gum before the infant was born.

FIG. 17.



Upper incisor tooth in infant at birth, natural size.

The first tooth may appear at any time during the first year of life, or may be delayed until the second year without any other apparent vice of development. In like manner, every kind of variation may be met with in the order in which the teeth appear, without the slightest evidence of any pathological condition, mental or

otherwise, being found either at the time or later. It is therefore unnecessary to alarm the parents by stating that their child is abnormal because it has not cut a tooth in the first year. We should, however, carefully watch these children and be sure that their food contains the proper nutritive elements not only for their age, but also for their individual digestion.

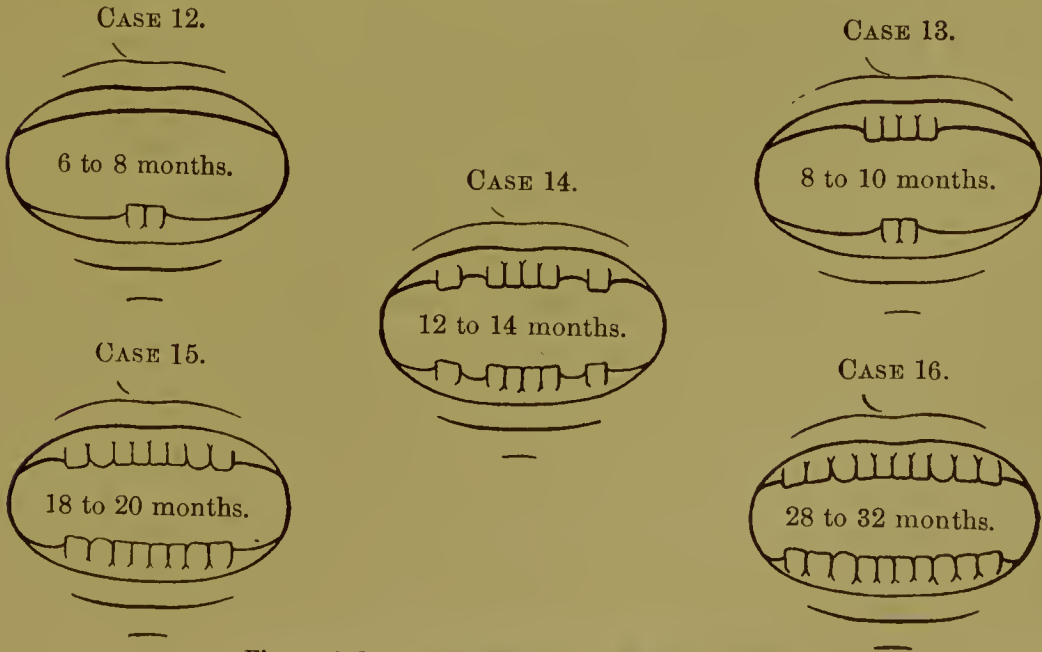
The appearance of the teeth in groups suggests certain practical divisions which I shall make use of in later lectures to determine various questions, such as the best time for weaning, or for vaccination. These divisions constitute the *dental* and *interdental periods*. In my individual experience, the first tooth appears at about the sixth or seventh month, though at times I find it much earlier, as at the fourth month, and later, as at the ninth, tenth, eleventh, or twelfth month. The first tooth which develops sufficiently to come through the gum is in most cases one of the middle lower incisors. The groups and the dental periods, allowing always for many variations, are, as I have noted them, as follows :

TABLE 12.

	<i>Temporary Teeth.</i>	<i>First Dentition.</i>	<i>Twenty in Number.</i>
	Dental Periods.		Groups of Teeth.
I.	6 to 8 months . . . . .		2 middle lower incisors.
II.	8 to 10 months . . . . .		4 upper incisors.
III.	12 to 14 months . . . . .		2 lateral lower incisors and 4 first molars.
IV.	18 to 20 months . . . . .		4 canines.
V.	28 to 32 months . . . . .		4 second molars.
			<hr/> 20

I shall now pick out a number of infants in these various periods who happen to have their teeth corresponding to them, and I should like you to examine their mouths. Here are five typical cases which will illustrate what I have just said.

DIAGRAM 4.



Five periods of development in the first dentition.



The second set of teeth begins to replace the first at about the sixth year, and this table will aid you in remembering their order :

TABLE 13.

Years.	Permanent Teeth.	Second Dentition.	Thirty-two in Number.
			Groups.
6	. . . . .		4 first molars.
7	. . . . .		4 middle incisors.
8	. . . . .		4 lateral incisors.
9	. . . . .		4 first bicuspid.
10	. . . . .		4 second bicuspid.
11	. . . . .		4 canines.
12	. . . . .		4 second molars.
17 to 25	. . . . .		4 third molars (wisdom teeth).
			32

The first four teeth of the second dentition are usually called the sixth-year molars. They do not replace any of the permanent teeth, but, the jaw having grown so as to provide space back of the temporary teeth, they appear back of and next to the second molars. This usually occurs at about the sixth year.

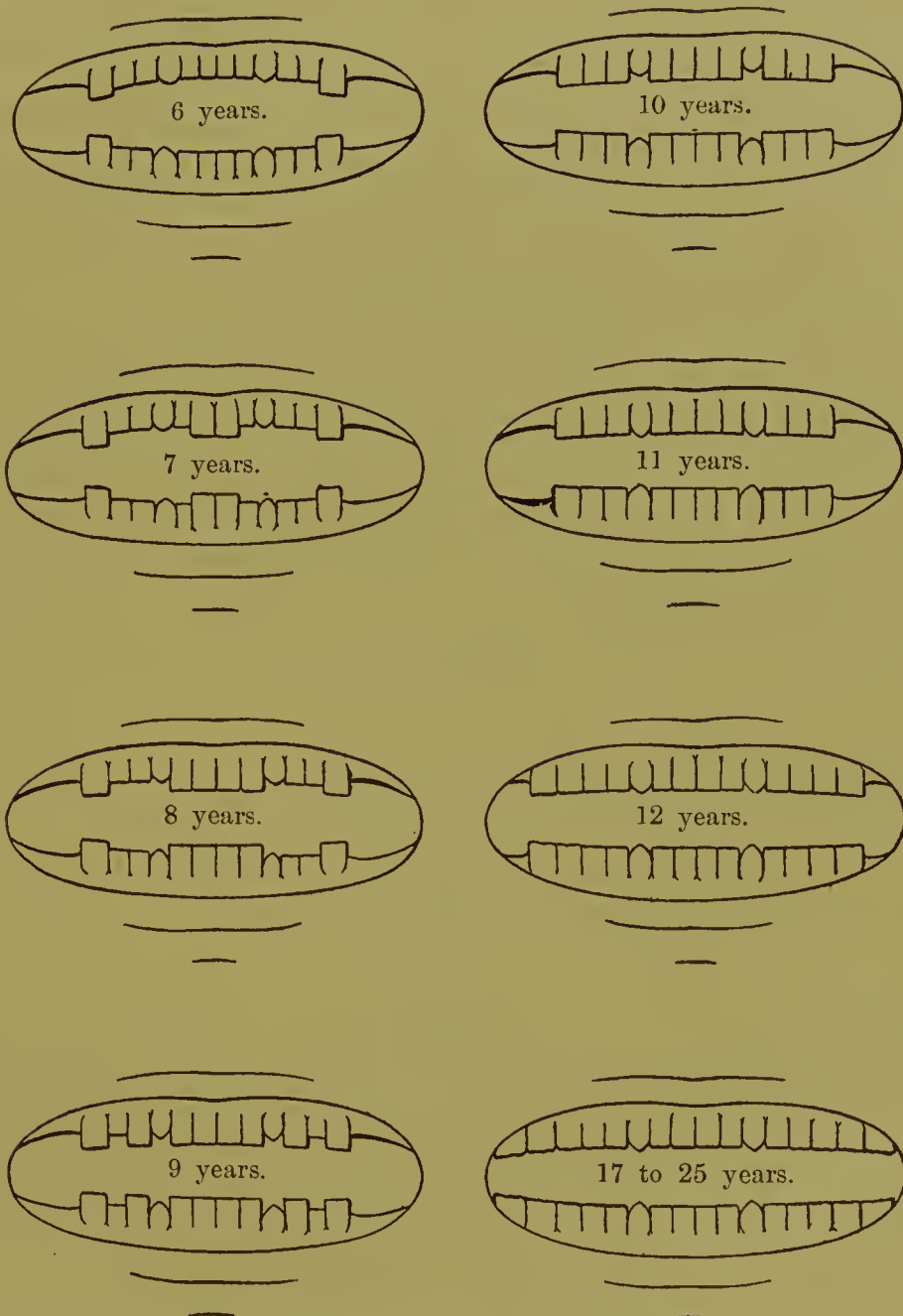
In the seventh and eighth years the permanent incisors replace those of the temporary set. In the ninth and tenth years the bicuspid replace the temporary molars. In the eleventh year the permanent canines replace the temporary, and in the twelfth year the four second molars appear. This really completes the second dentition of childhood, twenty-eight teeth. The remaining four molars belong to a period of adult growth. Diagram 5 (page 71) shows very clearly the manner in which the permanent teeth replace the temporary set between the ages of six and twenty-five years.

**THORAX.—TOP OF STERNUM.**—Professor Dwight found on examining two children each ten months old that the top of the sternum was in one nearly opposite the disk between the first and second dorsal vertebræ, and in the other a little lower, near the top of the second. In a black child of three years, whose proportions were strikingly infantile for her age, it was near the lower border of the first vertebra. In the three-year-old child the subject for the work on Dwight's "Frozen Sections" it was opposite the lower part of the second vertebra. In the median section of a boy about six years old Symington found the top of the sternum a little below the level of the top of the second dorsal vertebra; he believes, however, that this was an individual peculiarity, as in several children of that age he found nearly the adult relations. From several observations on the living subject Dwight is inclined to agree with this statement.

**DIAMETERS.**—The antero-posterior diameter of the interior of the thorax is to the transverse diameter at three years, according to Dwight's "Frozen Sections," as one to two, and in a child of from five to six (Symington) the depth is even relatively greater. The ribs bend much less backward than in the adult, and the back, as has been said, first becomes rounder and then

flatter. At four or five years great progress in growth has been made, and the infantile form of the thorax has wholly disappeared. Slight changes, however, probably go on for some years.

DIAGRAM 5.



Eight periods of development in the second dentition.

OSSIFICATION.—Towards the end of the first year the bone-centres of the sternum have grown, and the sternum has gained a good deal in stability. New points of ossification have probably appeared, but still the sternum is essentially cartilaginous, the bone merely consisting of islands in a sea of cartilage. At two years of age the manubrium and the second and third pieces are nearly ossified, but their shape is made by their cartilaginous borders. At three years I have twice seen the manubrium and the second

piece of the sternum presenting in bone their real shape, while the third piece was still framed in cartilage. Sometimes, however, the process of ossification is more backward. The ossification of the lower part of the sternum is less advanced than the upper part. As to its relative size opinions differ. While it seems to me that it is usually small, I must admit that statistics do not confirm this view. Probably the individual variation is very great. The ribs being comparatively horizontal, the cartilages rise very little, and at the lower part of the chest in front they are nearly together, making narrow intercostal spaces, the seventh cartilages often meeting below the body of the sternum. In the dead body of a young child, especially if it be emaciated, it is striking to see how, after the cadaveric rigidity has passed away, the sternum and cartilages, forming the front of the chest, fall in at the point where they join the ribs.

RESPIRATION.—At birth there is no decided type of respiration for the two sexes, as I have proved by a number of observations. As the infants, both male and female, however, grew older and a more equable respiratory mechanism became established, I found that, as a rule, in the early months of life the type of respiration was abdominal. This infant (Case 17), nine months old, presents the irregular respiration of infancy, but you see the type is distinctly abdominal.

CHART 2.



Respiration for one-half minute in a healthy infant nine months old : awake, but quiet.

DIAPHRAGM.—In a child three years old Dr. Dwight found the diaphragm to be opposite the lower part of the eighth vertebra, and in another child it was at the disk between the eighth and the ninth. Both the children were girls. In a boy of five it was opposite the middle of the ninth, and in one of six opposite a point in the lower half of the ninth; in a girl of six it was opposite a point between the ninth and the tenth, and in one of thirteen opposite the lower border of the ninth.

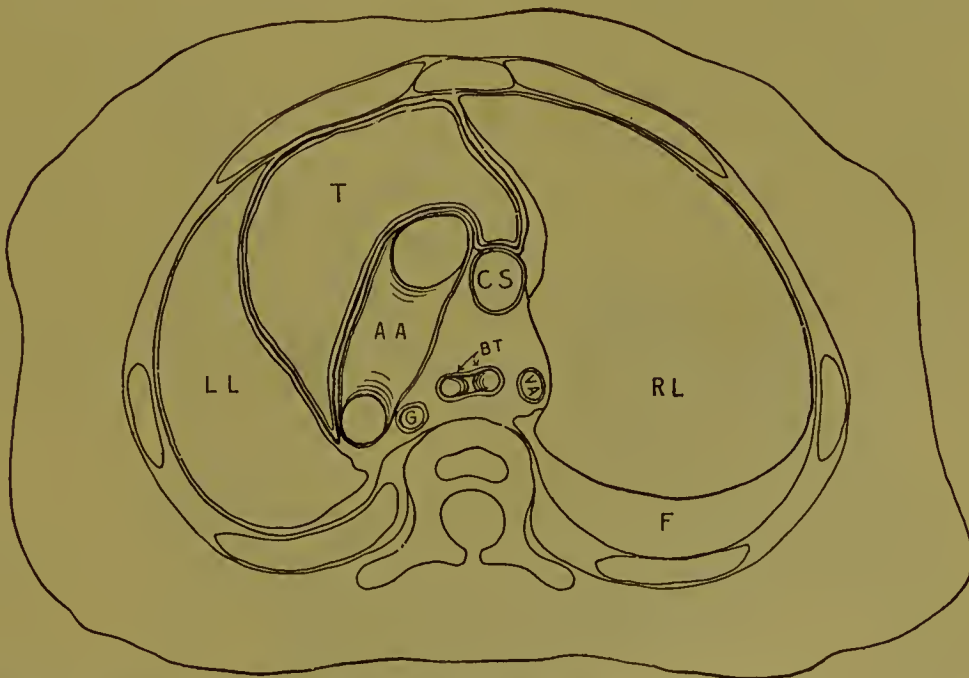
THYMUS GLAND.—The *thymus* is most developed in the first two years of life, but it persists longer than was formerly taught. During its greatest development it is found in the neck as well as in the thorax, extending perhaps 2 cm. ( $\frac{5}{8}$  inch) above the sternum, which, you must remember, is no small part of the surface of a child's neck. The thymus extends down the anterior mediastinum, lying on the pericardium in two long lobes on either side of the median line. The extent of these lobes is very variable, and the two are not usually symmetrical. I have seen them, even in an infant, so developed that the longer nearly reached the lower end of the sternum; but it is very uncommon for it to reach the diaphragm. These prolongations



become thinner as they descend. The thymus is a thick mass behind the first piece of the sternum, where it rests on the top of the heart against the great vessels concealing the innominate veins, more or less of the superior vena cava and the arch of the aorta, and extending back to the trachea. Lower down it extends on either side into the angle between the pericardium and the lungs, or rather pleuræ. Except for the front view, obtained by removing the sternum, the size and relation of the thymus are best shown by frozen sections. One, made by Dwight, of a child of three years or less, at the Harvard Medical School, gives a most remarkable view of it. The section in question runs nearly horizontally from the top of the fourth dorsal vertebra to just above the junction of the second costal cartilage with the sternum.

The cavity of the thorax seems to be divided into three parts, one on either side of the lungs and a median one occupied by the thymus, the transverse part of the arch of the aorta, with the superior vena cava on its right, and the trachea and œsophagus behind. The area occupied by the thymus is very nearly equal to that of the left lung. The thymus reaches backward on the left of the aorta behind the level of the front of the spinal column. There is also what seems to be a piece of it between the vena cava and the trachea. On the upper surface of the same section, at about the level of the sterno-clavicular articulations, it is in front of both innominate veins and behind the right one. The lungs are prevented from approaching each other so nearly behind the manubrium as they do in the adult.

FIG. 18.



Frozen section, child of three years: RL marks right lung; LL marks left lung; T marks thymus gland; G marks gullet; CS marks superior vena cava; AA marks aortic arch; VA marks vena azygos; F marks some fluid which happened to be in the right chest; BT marks bifurcation of trachea.

The section of the child just described shows that behind the manubrium there is much more of the thymus to the left than to the right of the median line, and its dulness on percussion must have been evident at

the left of the sternum. Below it merges into the cardiac dulness, and no distinction between them is possible.

The theoretical results of enlargement of the thymus are very serious. Resting on the anterior and weaker ventricle, which is prolonged upward into the pulmonary artery, it may interfere with the pulmonary supply of blood, and by compressing the innominate veins and the superior cava it may interrupt the return of venous blood to the lungs. Whether or not it may compress the thoracic duct is doubtful, but it certainly may press on the trachea.

The thymus is said often to persist for several years after puberty, but observations are not numerous on this point. It seems to disappear from the neck and from the front of the heart and to remain longest behind the first piece of the sternum.

For further information on this subject, I shall refer you to Dr. A. Jacobi's excellent monograph on the Anatomy and Pathology of the Thymus Gland.

HEART.—It is generally held that in the first year of life the long axis of the heart is more nearly horizontal than later. The apex is thought by many to be higher. I am inclined to think that this is true in the first few years, but somewhat later it may be found in the adult position, or, in cases where the lower part of the sternum is backward in development and the cartilages crowded together, it may be in a lower space than normal. It is not unlikely that a subsequent change in these portions of the walls would correct this. Thus, if in the early condition the apex were at the sixth intercostal space, a lengthening out of the lower end of the sternum might cause such a descent of the ribs as would bring it into the fifth space.

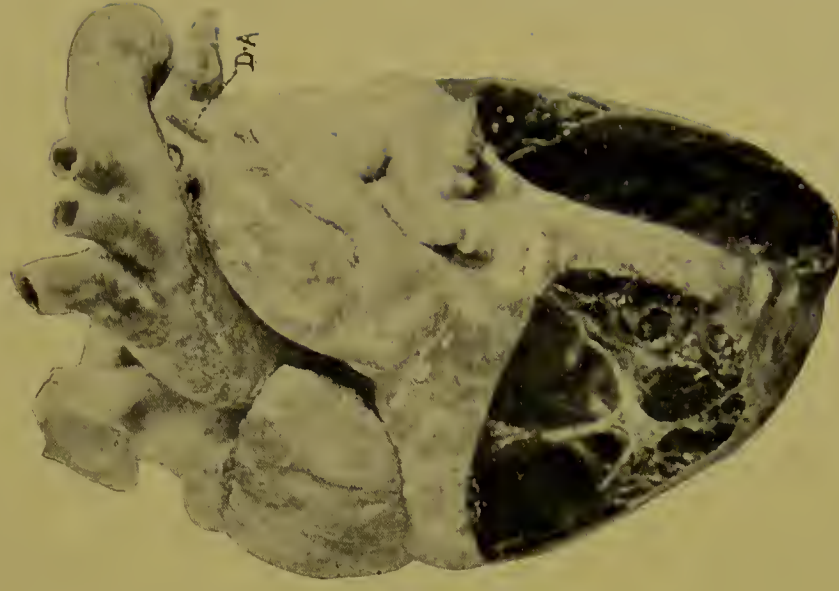
Weight.—As shown by Boyd, the weight of the heart in proportion to that of the whole body does not vary much at different ages, so that the relative labor of the heart does not materially differ between the young subject and the adult. In the first few years, however, the increase of the weight of the heart is greater than at about the fourth or fifth year, and this increase is again greater at about puberty. These are facts of practical importance to be remembered when we are studying the diseased conditions of the heart.

TABLE 14.  
*Weights of the Heart during its Development. (Boyd.)*

Age.	Grammes.
At birth . . . . .	20.6
1½ years . . . . .	44.5
3 years . . . . .	60.2
5½ years . . . . .	72.8
10½ years . . . . .	122.6
17 years . . . . .	233.7

I should now like you to examine carefully this heart of an infant in the early weeks of life (Figs. 19 and 20), at a period when the heart and blood-vessels have completely changed from the foetal type to that of the adult.

FIG. 20.



D A marks ductus arteriosus.

FIG. 19.



EV marks Eustachian valve ; FO marks foramen ovale.





It has been prepared by Dr. Franklin Dexter to show the different cavities and also the remains of the foetal conditions. First, looking into the right auricle (Fig. 19), you see the remains of the *Eustachian valve*, and the distinctly outlined but closed *foramen ovale*. Next, on turning the heart around (Fig. 20), you see this small tense cord connecting the aorta and the pulmonary artery. This is the obliterated *ductus arteriosus*, and, as you see, it pulls the aorta somewhat out of line, a condition which you will find to be of considerable significance when we are studying diseases of the heart.

**BLOOD-VESSELS.**—Jacobi, in speaking of the extensive work of Thoma on this subject, writes as follows :

“According to a number of actual observations made by R. Thoma, the post-foetal growth is relatively smallest in the common carotid, and largest in the renal and femoral arteries. Between these two extremes there are found the subclavian, aorta, and pulmonary arteries. These are differences which correspond with the differences in the growth of the several parts of the body supplied by those blood-vessels. In regard to the renal artery and the kidney, it has been found that the transverse section of the former grows more rapidly than the volume and weight of the latter. Thus, it ought to be expected that congestive and inflammatory processes in the renal tissue were almost predestined by this disproportion between the size of the artery and the condition of the tissue. Moreover, the resistance to the arterial current offered by the kidney substance depends also upon the readiness with which the current is permitted to pass the capillaries. It has been found experimentally that within a given time more water proportionately can be squeezed through them in the adult than in the child. These anatomical differences may therefore be the reason why renal diseases are so much more frequent in infancy and childhood from all causes, with the exception of that one which is reserved for the last decades of natural life, atheromatous degeneration.”

**Pulmonary Artery.**—Professor Dwight has found the origin of the pulmonary artery at ten months to be near the top of the first intercostal space and at the same age at the level of the second costal cartilage. At three years he found it near the lower border of the first space, also near the lower edge of the second cartilage, and again at about the lower part of the second space. On the whole, considering the great variations which occur in the adult, as recorded by Gibson and others, it is doubtful if there is any essential difference at different ages. If we say that in the infant it is rather higher than later we have stated about all that is justifiable.

**LUNGS.**—At what age the lungs reach their full expansion forward has not been determined. It would appear that it is not before five or six years, and it is probably still later. As the chest expands laterally the lungs of course increase, and the relatively greater size of the heart to the lung in the infant depends essentially on the size of the lungs. During the first year of life (according to Northrup) the alveolar walls are thick and their blood-vessels are held loosely. It is not until the fourth or fifth year that

the proportionate adult development between the alveoli and the bronchi is attained, and the stroma has become dense and binding, restraining the capillaries as in adult life. In infant life the underlying loose tissue lining the bronchial tubes gradually binds the mucous membrane to the fibro-muscular wall. From this time it keeps pace in its growth with the other compact tissues, until in adult life it appears as dense fibrous bands. During the first two years the air-cells have not attained the proportionate capacity which exists in adult life, and the bronchial tree is still large in proportion to the dilating and multiplying alveoli. Again the air-spaces developed from the terminal bronchi have covered themselves with a continuous layer of flat nucleated epithelium. In its subsequent growth in adult life it is believed that the expanding alveolus does not increase its number of epithelial cells to cover the more extended wall, but somewhat enlarges their size, and, still further, that some of the flattened epithelium loses its nuclei and expands to form large, very thin plates, called respiratory epithelium.



FIG. 21.



Stomach, spleen, and pancreas at 10 months. Natural size, posterior view. S marks the spleen; P marks the pancreas; D, the duodenum. Warren Museum, Harvard University.



## LECTURE IV.

ABDOMEN.—TEMPERATURE.—PULSE.—RESPIRATION.—HEIGHT.—WEIGHT.—FEET.—BONE MARROW.—SKIN.—CORD.—FUNCTIONS.—BLOOD.—LYMPHATIC SYSTEM.—URINE.—INTESTINAL DISCHARGES.—INFANTILE SKELETONS.—NORMAL INFANTS.—TOPOGRAPHICAL ANATOMY OF THE EARLY PERIODS OF LIFE.

ABDOMEN.—LIVER.—The liver is, as I have told you, proportionately large at birth and in early childhood, and, as I shall presently show you on the living subject, can be felt below the edge of the ribs in the right hypochondrium, its border being about 1 or 2 cm. ( $\frac{3}{8}$  to  $\frac{6}{8}$  inch) below the lower rib.

Gall-Bladder.—The fundus of the *gall-bladder*, according to McClellan, is in relation to the surface of the body about that of the ninth costal cartilage near the border of the right rectus muscle.

SPLEEN.—There is nothing especially to be noted in the spleen in childhood, as it corresponds in its position to that of the adult. According to Foster, the spleen grows rapidly in early infancy, but in proportion to that of the adult is both absolutely and relatively smaller. It is said that the spleen when enlarged encroaches more upon the thoracic cavity than in the adult, owing to the greater resistance offered by the costo-colic fold of the peritoneum upon which it rests. My clinical experience, however, does not especially support this view, as in many cases of enlarged spleen from varied causes which I have met in infants it has always seemed to me that the abdomen was encroached upon to a greater extent than in adults, and that both the physical and the rational signs of the enlarged spleen in the thorax were relatively insignificant and often difficult to detect.

PANCREAS.—The function and the anatomy of the pancreas correspond very closely to those of the salivary glands. It is situated in front of the first lumbar vertebra, behind the stomach, and, according to the variations produced by age and the growth of other parts, lies somewhere between the umbilicus and the ensiform cartilage.

The relative position of the spleen and pancreas to the stomach and duodenum is very beautifully shown in these organs obtained at the autopsy of an infant ten months old, which lately died in my wards. You see that the spleen is behind the cardiac end of the stomach, and very near its extremity (Fig. 21, facing page 76 ; organs seen from behind). You will also notice how the pancreas extends from the spleen (its tail being in close apposition to the latter organ) along the posterior surface of the stomach and somewhat upward to the smaller curvature, passing behind the duodenum



and its head resting in the concavity of the duodenum. The curve of the duodenum is also clearly shown in the specimen.

**KIDNEYS.**—The kidneys are lobulated at birth, as I showed you in the specimen taken from an infant three days old. (Division I., Lecture II., Fig. 9, page 44.) This condition continues for a long time and then disappears, the lobulation being represented by the pyramids of Malpighi. A few years after birth the position and relations of the kidney approximate those of the adult (McClellan).

**Supra-renal Capsules.**—The supra-renal capsules are, as I have told you in Lecture II., relatively large in size, and gradually approach the adult proportions as the child grows older.

**BLADDER.**—Although small at birth, the bladder soon becomes capable of great distention.

Symington, from a frozen section which he made in the median plane through the body of a child seven months old, shows the position of the bladder, which happened to be distended. It takes up, practically, the whole of the lower portion of the abdomen, an observation which at once presents to our minds the difficulty of making a correct physical examination of the infantile abdomen during life, unless we are sure that the bladder is empty.

The above fact was strikingly exemplified in this little girl, three years old (Case 18),

CASE 18.



Girl 3 years old. Distended bladder.

who entered my wards at the Children's Hospital yesterday. She was sent to the hospital for an examination in reference to the advisability of an operation to remove an abdominal tumor. On inspection, a rounded prominence extending from the pubes to 3 cm. ( $1\frac{1}{4}$  inches) above the umbilicus could be plainly seen. By palpation the tumor could be felt extending from the right inguinal region over to the crest of the left ilium. The tumor was soft, elastic, and fluctuating. It was evidently not in the abdominal walls, but intra-abdominal. The child was said to have been ailing for over a week, and to have grown thin. She passed her urine frequently, but in small quantities. Nothing abnormal had been found on an analysis of the urine made before she entered the hospital. You see I have marked in black the outline of the tumor as it appeared on entrance.

Suspecting a distended bladder, I had a catheter introduced, and removed 270 grammes (9 ounces) of urine. The tumor immediately disappeared, and, as you see, the abdomen is now soft and resonant.

A practical lesson to be drawn from this case is, that the bladder should invariably be carefully examined and emptied before diagnosing or

operating for abdominal disease. I have seen a distinguished laparotomist neglect this precaution in a young child while operating for appendicitis, and on opening the abdominal cavity cut directly through the walls of the bladder. The urine flowing out through the wound was the first indication to him that he had failed to appreciate that in early life the bladder is essentially an abdominal organ.

You can see that many peculiarities of the digestive tract may arise from the causes which I have already spoken of in Lecture II. Especially to be noticed, however, are those which are due to the different proportionate stages of development of the parts of the gastro-enteric tract at different ages, and to differences in their peritoneal attachments.

**STOMACH.**—The stomach grows very rapidly, and peculiarities of shape appear at an early age. I have seen a stomach of four and one-half months which, although small, was relatively broader than in the adult. The adult shape, however, is soon acquired. How permanent this may be is as yet unsettled. There is no doubt that great dilatation may be induced, and it is highly probable that where too small quantities of food are given the normal stomach will contract. It is also very likely that certain shapes are acquired at a very early period. I have seen in a young child a well-marked *antrum pylori*,—that is, a pouch above the pylorus, which, in extreme cases, forms almost a separate chamber. It is evident that the clinical significance of our anatomical knowledge of the growth of the stomach in the first year is very great. This question of growth is, in fact, one of the most important factors in the problem of the substitute feeding of infants, and a lack of its thorough comprehension often leads to most unfortunate results.

**Capacity.**—There has been much dispute as to the proper method of determining the gastric capacity during infancy. All methods of which I know are open to criticism, but I have found that by combining all the methods and making general deductions I have arrived at very practical conclusions concerning the size of the stomach at different ages. I have also found that my results correspond closely to those of others who have made careful studies of this subject, notably Fleischmann of Vienna, and Holt of New York. One of the methods which I have employed has been a clinical one, which I shall show you, as I happen to have a wet-nurse with a healthy baby four months old here in the ward.

[CASE 19.] The mother is healthy, and has plenty of milk in her breasts. Her milk is evidently in equilibrium, and agrees with her baby, who is digesting it well and gaining about 30 c.e. (1 ounce) a day. Now, if we wish to determine the gastric capacity of an infant's stomach at four months we can experiment with this infant. The weight of 30 c.e. (1 fluid-ounce) of human milk is very nearly 30 grammes (1 ounce). If then we introduce 30 c.e. (1 ounce) of milk into an infant and weigh it immediately before and immediately after the introduction, the infant should increase 30 grammes (1 ounce) in weight. This method I have proved a number of times to be fairly correct, as you see it is in this especial case (Case 19) within four or five grammes. It is well known among those who deal in cattle that when fat cattle are transported long distances, as from Chicago to New York, they are found to



have lost materially in weight, perhaps thirty or forty pounds. Now, if these cattle are allowed to fill their stomachs with water, an increase in their weight will be found corresponding exactly to the weight of the water which they have drunk. I find that this infant (Case 19) weighs before nursing 7030 grammes ( $15\frac{1}{2}$  pounds). We will now let it nurse until it evidently is satisfied, that is, practically until it feels that its stomach is full. I then immediately weigh it again, and find that it has increased to 7145 grammes ( $15\frac{3}{4}$  pounds), a gain of 115 grammes (about 4 ounces). This would, in a general way, denote that the gastric capacity of this especial infant was 120 c.c. (4 ounces).

Now, if a number of healthy infants of different ages and of average weights are fed and weighed in this way, we can approximately by comparing the gains in weight which correspond to the same ages determine the gastric capacity for each age. I should not, however, consider this by itself a reliable method for determining the gastric capacity, as it is open to many objections, which need not be discussed at present. One source of error, for instance, is the variation of the infant's appetite, which may cause either too great distention or underfilling of its stomach. Another method which I have used is the actual measurement of the gastric capacity at the autopsy, with suitable precautions to avoid over-distention. Combining these methods, I have arrived at certain general conclusions, which I shall give you in figures. I have in this way also determined that the stomach grows very rapidly in the first three months after birth, grows slowly in the fourth month, and is then almost quiescent for about two months. It then begins to grow again until it has reached its adult size. Frolovsky's rules for determining the gastric capacity of young infants approximate in their results so closely my own investigations that I have prepared from them this table of infants' stomachs at different ages and at different periods of growth. The tracings of the stomachs are life-size. Frolovsky shows that the activity of the stomach's growth is very great in the first quarter of the first year, that it is very slight in the second quarter, and that it again shows a moderate activity in the last part of the year. He represents this activity of the stomach's growth by the ratio of 1 for the first week to  $2\frac{1}{2}$  for the fourth week and  $3\frac{1}{5}$  for the eighth week, while it is only  $3\frac{1}{3}$  for the twelfth week,  $3\frac{4}{7}$  for the sixteenth week, and  $3\frac{2}{5}$  for the twentieth week. As a starting-point from which to calculate the above proportions I have taken the infant's stomach which I presented to you at my lecture on the Infant at Term as representing a fair average capacity for this age, 25 to 30 c.c. ( $\frac{5}{6}$  to 1 ounce) (page 45, Fig. 10).

This, of course, is also intended to represent an infant with the average birth weight. This table will with its six tracings explain what I have just said about the rapid increase in size which the stomach shows at the periods I have mentioned (Table 15).



TABLE 15.

*Gastric Capacity in the First Five Months of Life.*

I.



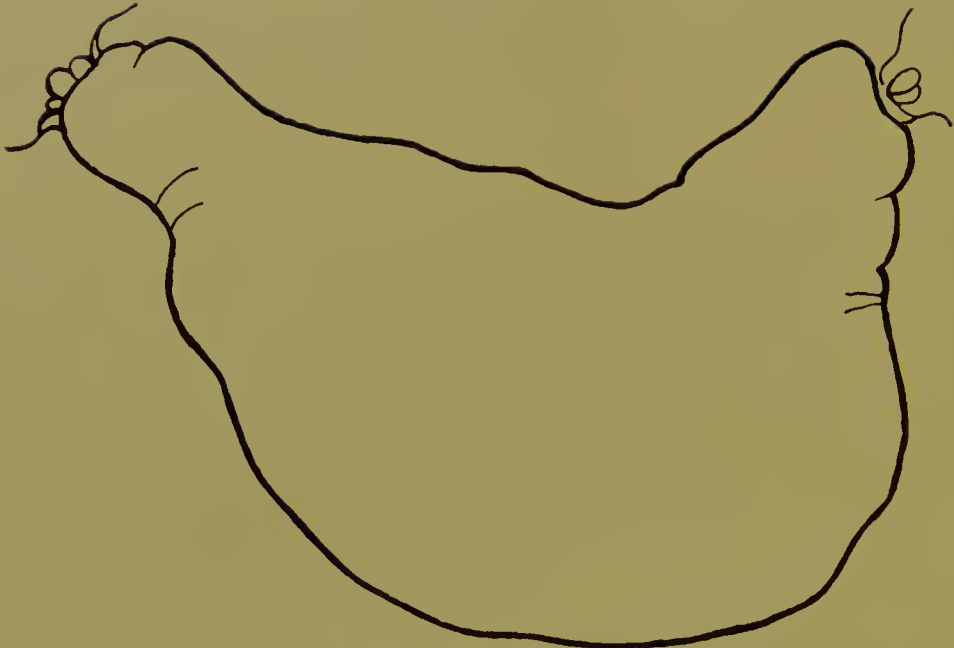
Infant 3 hours old. Capacity of stomach 25 to 30 c.c. ( $\frac{1}{8}$  to 1 ounce).

II.



Infant 4 weeks old. Stomach  $2\frac{1}{2}$  times larger than I. Capacity 75 c.c. ( $2\frac{1}{2}$  ounces).

## III.



Infant 8 weeks old. Stomach  $3\frac{1}{2}$  times larger than I. Capacity, 96 c.c. ( $3\frac{1}{2}$  ounces).

## IV.



Infant 12 weeks old. Stomach  $3\frac{1}{3}$  times larger than I. Capacity, 100 c.c. ( $3\frac{1}{3}$  ounces).

V.



Infant 16 weeks old. Stomach  $3\frac{1}{4}$  times larger than I. Capacity, 107 c.c. (3.56 ounces).

VI.



Infant 20 weeks old. Stomach  $3\frac{3}{8}$  times larger than I. Capacity, 108 c.c. (3.6 ounces).



In comparing these measurements with actual stomachs, the gastric capacity as given for sixteen and twenty weeks is somewhat small. I consider, however, that they are extremely valuable to begin with, as it is always better to err on the side of giving too little food than too much.

As has been admirably pointed out by Fleischmann, the gastric capacity is greater at the same age in the artificially-fed than in the breast-fed infant. This observation, however, in all probability only emphasizes the importance of bearing in mind the normal gastric capacity of the different ages, and of using this knowledge to prevent the overfeeding which has produced so noticeable a difference between the sizes of the stomach in breast-fed and in artificially-fed infants.

Since I have developed my methods of substitute-feeding in connection with milk modification, I have no reason to suppose that when the infant's stomach has been properly managed, as I can now accomplish in substitute-feeding, it is any larger than in breast-fed infants.

The cause, however, which produces the most uniform individual difference in the gastric capacity at the same age is the weight of the infant. I am inclined from the results of my own observations in a considerable number of

FIG. 22.



Stomach of infant 12 months old, natural size. Gastric capacity, 90-105 c.c. Weight, 4289 grammes.

cases to agree with Fleischmann's statement, that the greater the weight the greater the gastric capacity. A good illustration of the correctness of this rule has lately come under my notice, where (Case 20) a breast-fed infant of twelve months with a stomach (Fig. 22) normal in shape presented a gastric

capacity of only 90 to 105 c.c. (3 to  $3\frac{1}{2}$  ounces). This capacity corresponded to its weight, 4289 grammes ( $9\frac{1}{2}$  pounds), about the average normal weight of an infant at eight or ten weeks, rather than to its age, which in the average infant would present a gastric capacity of 240 cubic centimetres (8 ounces).

I have also had under my care an infant of six weeks whose general development and weight corresponded so closely to those of the normal average infant of twelve weeks that it was self-evident that the two ounces of food which would ordinarily have been the proper allowance, so far as the age was concerned, was not sufficient, and that its weight indicated a gastric capacity for an allowance of four ounces, which, in fact, it took and digested with the greatest ease, while with any amount less than the four ounces it was never satisfied.

It will now, I think, be instructive for you to examine these stomachs which from time to time I have obtained at autopsies, and see how they compare with the measurements which I have just given you. Dr. Townsend, who prepared most of these specimens, drew my attention to the important fact that in measuring the gastric capacity it should be done before the stomach is separated from its mesenteric attachment, as otherwise it is easily stretched by the fluid introduced, and will then show a greater capacity than would be within the normal limits during life. I have had some of the stomachs distended beyond their natural size in order to show you how misleading it would be to depend for exact results on this method of investigation. You will therefore find quite a variety of figures representing the gastric capacities, but on the whole they correspond so closely to the rule already stated that they corroborate rather than disagree with the other methods. It is interesting also to note the different shapes which these stomachs represent, as some of them are very different from the usual classical figures represented in books. So far as I could ascertain, these shapes did not occur from any especial disease, such as would influence the outline of the stomach, as has happened in this specimen taken from a case of rachitis. (Page 849, Fig. 108.)

(The illustrations represent the actual sizes of the stomachs.)

Beginning with the youngest subject, an infant three hours old, you see, as I have already shown you at a previous lecture (Division I., Lecture II., Fig. 10, page 45), that the stomach has the average capacity of the newborn, 25 c.c. ( $\frac{5}{8}$  ounce), although the infant's weight was only 2500 grammes ( $5\frac{1}{2}$  pounds).

The next stomach (Fig. 23, page 86) was taken from an infant two and one-half days old, and weighing 4000 grammes ( $8\frac{4}{5}$  pounds). The gastric capacity is 25 c.c. ( $\frac{5}{8}$  ounce).

This next stomach (Fig. 24, page 86) was taken from an infant five days old and weighing 3000 grammes ( $6\frac{3}{5}$  pounds). The gastric capacity is 25 c.c. ( $\frac{5}{8}$  ounce).

This stomach (Fig. 25, page 87) was taken from an infant seven days



old and weighing 2700 grammes ( $6\frac{1}{8}$  pounds). Its gastric capacity is 40 c.c. ( $1\frac{1}{3}$  ounces).

These four stomachs (Fig. 10, page 45, Fig. 23, Fig. 24, Fig. 25), all taken from infants within the first week of life, show us at once that we

FIG. 23.



Stomach of infant  $2\frac{1}{2}$  days old, natural size. Gastric capacity, 25 c.c. Weight, 4000 grammes.

cannot always depend on an infant's weight for determining its gastric capacity in the early days of life. Thus, the weights of 2500 grammes, 3000 grammes, and 4000 grammes all had the same gastric capacity of 25 c.c. Again, the weight of 2700 grammes had a greater capacity, 40 c.c.,

FIG. 24.



Stomach of infant 5 days old, natural size. Gastric capacity, 25 c.c. Weight, 3000 grammes.

than the weights of 3000 and 4000 grammes. We must, however, also allow that there might be an error in measuring the gastric capacity.

Do not for a moment think that I am deducing any rules for growth from



FIG. 25.



Stomach of infant 7 days old, natural size (posterior view.) Gastric capacity, 40 c.c. Weight, 2700 grammes.

this very limited number of cases. You will, however, understand the significance of these figures a little later when we are discussing the feeding

FIG. 26.



Stomach of infant 12 days old, distended to hold 80 c.c. Natural gastric capacity, 40 c.c.

of the early days of life. This next stomach (Fig. 26) is from an infant

twelve days old. I have, unfortunately, lost the record of its weight. It represents very well, however, the usual shape and position of the stomach in early life, and I have had it distended beyond the limit of its normal capacity, so as to show you the great elasticity of the ventricular walls to which I have already referred. The gastric capacity was about 40 c.c. ( $1\frac{1}{3}$  ounces). As you see it now distended, it holds 80 c.c. ( $2\frac{2}{3}$  ounces).

This next specimen (Fig. 27) shows the stomach, duodenum, spleen, and pancreas of a well-developed infant five months old, 66 cm. (26 inches) long,

FIG. 27.



Stomach of infant 5 months old (posterior view). Weight, 6000 grammes. Distended to hold 225 c.c. Natural gastric capacity, 120 c.c. S marks the spleen; P the pancreas; D the duodenum.

and weighing by estimate about 6000 grammes (13 pounds). Its gastric capacity was about 120 c.c. (4 ounces). I have had it distended so that it now holds 225 c.c. ( $7\frac{1}{2}$  ounces).

FIG. 28.



Stomach of infant 7 months old (posterior view). Weight, 5230 grammes ( $11\frac{3}{4}$  pounds). Its gastric capacity was about 150 c.c. (5 ounces), but it has been distended to just twice its size and now holds 300 c.c. (10 ounces) (Page 89.)





FIG. 29.



Stomach of infant 7 months old, natural size. Weight, 5500 grammes. Gastric capacity, 220 c.c.  
Dry preparation (page 89).

FIG. 30.



Stomach of infant 19 months old, natural size (posterior view). Weight, 6270 grammes. Gastric capacity, 300 c.c.



This next stomach (Fig. 29) came from an infant seven months old and weighing 5500 grammes (12 pounds). Its capacity is 220 c.c. ( $7\frac{1}{3}$  ounces).

This stomach (Fig. 30) was taken from an infant nineteen months old and weighing 6270 grammes ( $13\frac{3}{4}$  pounds). Its capacity is about 300 c.c. (10 ounces).

I wish you to understand that I do not make any definite deductions from the last four cases. The stomach at nineteen months is especially unreliable as to its capacity. It was very distensible, and could easily by the mere weight of the water be made to hold 450 to 600 grammes (15 to 20 ounces). It gives, however, a very fair idea as to how the stomach looks at this age. This seven-months' stomach (Fig. 28, facing page 88) in its capacity corresponds to the weight, which is that of an infant of four months, while this other seven-months' stomach (Fig. 29) seems in its capacity to correspond to the infant's age rather than to its weight, which is that of the average infant at four months.

I have now treated this question of gastric capacity by the more exact methods of weighing and careful calculation, and also by the usually inexact method of direct measurement. Both methods, however, result in a general uniformity of figures and give us very fair data by which we can be guided when we come to the question of infant feeding.

It will be seen that the general principle of activity of growth is well represented in these figures.

The gastric capacity, however, in the third, fourth, and fifth months may appear rather small, and considerable differences will arise in the measurements of different observers. This, however, only impresses on us that we have not yet solved the problem of gastric capacity by any system of measurement. When all observers have agreed to make use of a mathematically precise and constant pressure in measuring the stomach, we may possibly arrive at more uniform results. Even then the degree of elasticity will be found to differ so greatly in the individual stomach that most diverse measurements will result.

There is no doubt that the value of these calculations lies in making us recognize evident changes in the activity of growth at certain periods; in making us allow that great differences arise irrespective of age and weight; in impressing us with the fact that the gastric capacity has been over- rather than under-estimated, and in enunciating that more exact clinical observations should be employed to reinforce our anatomical and physiological data.

During the last two and a half years I have been enabled through the aid of a milk laboratory to adapt exactly to the apparent needs of the infants under my care, as well as to their age and weight, the amounts of food on which they have seemed to thrive. It will be interesting and instructive to compare the following table with the figures and calculations which I have just shown to you, and thus see if my practical clinical results have corresponded to my experimental deductions.

The following figures represent the average amounts of food taken at

different periods during their first year by three hundred and forty-one infants. They were all well and strong, of average weight, and all were thriving and steadily gaining during the year. They received only stated amounts of food carefully ordered by prescription at the Milk Laboratory, and were watched with the greatest care to see when they evidently were hungry enough to have the total amount of their food increased. Of course the opportunity for exact work is almost unlimited where one has a milk laboratory at his command, and it has therefore seemed to me that this method of determining the gastric capacity is an unusually good one, and one which has never thoroughly been carried out before. Before showing you the table of the general averages, I will pick out one case to explain the significance of the general figures.

This infant (Case 21) was fed with the greatest care both as to the quality and as to the quantity of its food. The following figures represent the amount of food given at each meal from birth to ten months :

TABLE 16.  
*Amounts of Food in an Especial Case.*

Age.	Cubic Centi- metres.	Ounces.	Age.	Cubic Centi- metres.	Ounces.
Birth . . . . .	30	1	6 months . . . . .	150	5
4 weeks . . . . .	45	1½	7 months . . . . .	150	5
8 weeks . . . . .	60	2	8 months . . . . .	150	5
12 weeks . . . . .	75	2½	9 months . . . . .	195	6½
16 weeks . . . . .	90	3	10 months . . . . .	240	8
20 weeks . . . . .	132	4½			

This case shows the necessity for frequent and great increase of the total amount in the first four or five months, the comparative quiescence of growth in the sixth, seventh, and eighth months, and the increase again in the ninth and tenth months. It does not, however, correspond so closely to my previous results as does this table, where averages taken from the three hundred and forty-one cases already referred to are given.

TABLE 17.  
*Three Hundred and Forty-One Infants fed at the Milk Laboratory.*

Age.	Number of Cases for each Age.	Average Amount of Food at each Feeding.	
		C.c.	Ounces.
Birth . . . . .	45	29.4	0.98
4 weeks . . . . .	76	70.5	2.35
8 weeks . . . . .	84	96.6	3.22
12 weeks . . . . .	97	118.8	3.96
16 weeks . . . . .	87	137.0	4.57
20 weeks . . . . .	86	158.4	5.28
6 months . . . . .	73	171.3	5.71
7 months . . . . .	56	185.4	6.18
8 months . . . . .	54	208.5	6.95
9 months . . . . .	45	226.2	7.54
10 months . . . . .	33	238.8	7.89
11 months . . . . .	28	242.0	8.07

In this table the same infant has of course been recorded a number of times at different ages.



The whole question of gastric capacity is so closely connected with the subject of infant feeding that I shall leave it for the present, and speak of it more in detail later, when it will be seen to be of infinite importance in our attempts to regulate the substitute feeding of infants.

**INTESTINE.—Small Intestine.**—During the first month after birth, it may be reckoned that the small intestine will grow about two feet (about sixty-one centimetres), and a like rate of growth may usually be recorded at the end of the second month of extra-uterine life; but after that period its development proceeds in a most irregular manner. Thus, in a child of one year the small intestine measured eighteen feet (about five hundred and forty-nine centimetres), while in another, aged two years, the length was only thirteen feet eight inches (four hundred and seventeen centimetres). Again, in a child aged six years the small intestine was no less than twenty-one feet (about six hundred and forty and five-tenths centimetres) in length, while in another child, eleven years of age, its length was fourteen feet (about four hundred and twenty-seven centimetres).

I agree with Mr. Treves that the great variations which appear so early in the length of the small intestine bear no relation to the growth of the child. They probably depend on the diet. Not only the quantity but the quality of the food is an important factor in the growth of the intestine. The amount of residue, also, and the more or less irritating qualities of the food, must all have their effect.

As to the internal structure of the small intestine below the duodenum I can only say that I confirm the view now generally accepted, that Peyer's patches are found very early. I have seen them at three days and again at thirteen days.

In another case, sixteen months old, Peyer's patches were found, and one of them was five inches long.

**Large Intestine.**—Treves has also observed that up to three or even four months the length remains the same, but that nevertheless a remarkable change occurs. This is that the large intestine grows at the expense of the sigmoid flexure, which at birth is nearly one-half of the large intestine, while at four months it has assumed about its permanent proportion. Treves found the large intestine to measure at one year two feet and six inches (about seventy-six centimetres); at six years about three feet (about ninety-one and five-tenths centimetres); and at thirteen years about three feet and six inches (about one hundred and seven centimetres). I find among my notes the following measurements of the intestine.

TABLE 18. (Dwight.)

Sex.	Age.	Small Intestine.	Large Intestine.
Girl . . . . .	13 days.	292.9 cm.	48.5 cm.
Girl . . . . .	10 months.	670.0 cm.	78.0 cm.
Boy . . . . .	10 months.	435.0 cm.	90.0 cm.
Girl . . . . .	3 years.	490.0 cm.	84.0 cm.



*Cæcum and Ascending Colon.*—In about thirty-five observations on children under four years of age, most of them new-born infants, the cæcum was found in about thirty cases to range from the right lumbar region to the lower part of the iliac fossa. It was very frequently found at the junction of the rather vague lumbar and iliac regions. More or less would usually be found between two parallel horizontal lines, one at the level of the highest point of the crest of the ilium and the other at its anterior superior spinous process. In five cases the cæcum was either in the right iliac fossa or over the true pelvis, the fact being that it was so free as to have no fixed habitation. It is comparatively recently that the truth has been recognized in America, England, and France that normally the cæcum is at every age completely invested by the peritoneum, and that the idea that a large part of the posterior surface rests on areolar tissue without any intervening serous membrane is baseless, except in rare instances.

In young children the ascending colon differs in some respects from that of the adult. Owing to the high position of the cæcum, to say nothing of the relatively greater size of the liver, it is very short. There is no question that the ascending colon much more frequently has a mesentery than in the adult, and also that a relatively larger portion of the part above the cæcum is also invested with peritoneum so as to be absolutely free. More than once Dwight has seen the cæcum and a large part of the ascending colon in this condition. As to the question of how frequently more or less of the back of the cæcum may lack its peritoneal covering, in which case of course it is bound down to the parts beneath it, Dwight's observations are rather remarkable. Treves in his Hunterian Lectures stated that in one hundred observations he never found the posterior peritoneal covering wanting. Tuffier examined one hundred and twenty subjects, adults, children, and fetuses, and found the posterior surface uncovered in nine, all of whom were old people. I have kept no systematic record of Professor Dwight's observations on adults, but have the following report of thirty-seven young children. In thirty-three the cæcum was completely invested with peritoneum. In four children, all new-born or only a few days old, the whole or a large part of the back of the cæcum was without peritoneum.

Considering that this condition is much more likely to occur in the adult, and that, so far as we know, no one else has observed it in the infant, I am inclined to think that Dwight's large number of cases (four out of thirty-seven) must be considered an accident, such as is liable to happen where a series of observations is small. Professor Dwight believes that the cæcum of the infant and that of the young child are much more movable than that of the adult, and are also usually situated higher.

*Vermiform Appendix.*—The length and direction of the vermiform appendix are very variable. I have found it six and a half centimetres (two and five-eighths inches) long in a girl of thirteen days, five and three-tenths centimetres (two and one-eighth inches) in one of three years, eight centimetres (three and one-quarter inches) in one of ten months, and seven and

a half centimetres (three inches) in a girl eleven weeks old. The vermiform appendix in the first of these cases was so peculiarly placed as to deserve a few words of description. Only a small part was free, the rest being held by a small mesentery to the cæcum and the ascending colon. It arose from the posterior side of the cæcum, and ran backward to above the crest of the ilium, where it entered a little peritoneal pouch in the rear wall of the abdomen, and then, turning on itself, ran forward again. The entrance to the pouch was guarded below by a semilunar fold of peritoneum, with its cavity looking upward. It would appear from Treves's researches that the foetal shape of the cæcum is that of a pouch hanging down from the point of junction of the small and the large intestine and continued into the appendix, which grows symmetrically from the middle. Later, however, an irregular growth of one side of the cæcum generally leaves the origin of the appendix near the end of the ileum. Dwight has found that this condition usually prevails in the child. The position and direction of the appendix are most uncertain. It is, however, I believe, as a rule, on the posterior side of the cæcum. Its little mesentery passes to its beginning from the cæcum and is only exceptionally attached to the walls of the abdomen or pelvis.

The importance of the lymphatic glands about the cæcum as possible starting-points of inflammation is very great. Tuffier states that the lymphatics of the front of the cæcum follow the anterior ileo-cæcal artery to empty into two glands which he has found constantly in the superior ileo-cæcal fold, and which are very distinct in the child. The posterior glands are also found constantly on the posterior and inner wall of the cæcum itself beneath the peritoneum. They usually form a group of from three to six.

*Sigmoid Flexure.*—Dwight's observations on the sigmoid flexure in infancy show much diversity. In some cases it is obviously very long, in others apparently of about the adult proportions. As he has made accurate measurements in but few cases, I hesitate to make precise statements, but very frequently even at birth there was no evident departure from the normal adult proportions. A difficulty in this inquiry, which, however, is in itself an important point in anatomy, is to decide where the descending colon ends and the sigmoid flexure begins. Thus, in a girl of ten months the first impression was that the latter was not relatively longer than in the adult; but it was found later that what must be called the descending colon proper was very short, ending above the top of the crest of the ilium. This portion, a little over an inch in length, had a retro-peritoneal surface. The mesentery then began, and was attached obliquely across the psoas down to the front of the cæcum, where it became the meso-rectum. Thus the greater part of the descending colon formed one loop or series of folds with the sigmoid flexure; and this is by no means the only time that Professor Dwight has pointed out this arrangement. This loop which I have just described was also found to be very movable. The greatest breadth of the mesentery was four and eight-tenths centimetres (about two inches). In another child of the same age it was seven centimetres (about two and seven-eighths inches). I am inclined to think that



even in infants, in whom the sigmoid flexure does not, as a rule, seem large, it often has a relatively broad mesentery, allowing free displacement. In two children of three years the sigmoid flexure did not seem to exceed the adult proportion.

*Descending Colon.*—As is well known, the descending colon usually has no mesentery, but still one is often found. Lesshaft, in his observations made on subjects of many different ages, found it once in six times. Dwight, in rather more than twenty infants, found a mesentery to the descending colon in about half the cases. It is remarkable that Lesshaft found a mesentery less often in young subjects than in others. I find that a great part of the large intestines in infants is less fixed than in adults. I unfortunately, however, have not had at my command sufficient material to enable me to say when the mature condition is reached.

**TEMPERATURE.**—The temperature of the infant at term, although varying within a slight limit, is usually slightly raised. Very soon, however, as would be expected from the tax which is immediately made on its vitality by so many new surroundings, the temperature falls rather below the normal adult standard. In about a week the normal infant has recovered its equilibrium, and, if its nutriment has also been properly adapted to its digestive peculiarities, it usually presents the average normal adult temperature, 36.8° C. (98.2° F.).

TABLE 19.

*Temperature of Infant at Term.*

At birth . . . . .	37.2° C. (99° F.).
Within an hour . . . . .	36.1°–35.5° C. (97°–96° F.).
In about a week . . . . .	36.8° C. (98.2° F.).

These figures are the average of a large number, and are subject to great variations, as is seen on comparing them with a number of observations undertaken at my request by Dr. C. W. Townsend at the Boston Lying-in Hospital :

TABLE 20.

*Townsend's Temperature Observations.*

Temperature.		Temperature.	
Age.		Age.	
1 day . . . . .	37.2° C. (99° F.).	9 days . . . . .	37.4° C. (99.4° F.).
2 days . . . . .	37.3° C. (99.2° F.).	9 days . . . . .	37.1° C. (98.8° F.).
5 days . . . . .	36.6° C. (98° F.).	9 days . . . . .	36.9° C. (98.4° F.).
5 days . . . . .	37.5° C. (99.5° F.).	10 days . . . . .	37.1° C. (98.8° F.).
6 days . . . . .	37.3° C. (99.1° F.).	13 days . . . . .	37.2° C. (99° F.).
7 days . . . . .	37.5° C. (99.5° F.).	13 days . . . . .	37.3° C. (99.2° F.).
7 days . . . . .	37.2° C. (99° F.).	16 days . . . . .	37.3° C. (99.2° F.).
7 days . . . . .	37° C. (98.5° F.).	20 days . . . . .	37.3° C. (99.2° F.).

**PULSE.**—The pulse in uterine life is, as a rule, somewhat higher in girls than in boys, the former being about 130 to 140, and the latter 120 to 130. Anything over 130 points towards the female sex, but these figures as a means



of distinguishing the sexes before birth are not to be relied upon. At birth the pulse soon falls somewhat, and, as I have already told you, may be quite irregular. This, as a rule, is merely what we should expect would be the result of the sudden and great change which has taken place in the circulatory mechanism, and of the additional force which the heart is called upon to supply when it becomes the central station from which the blood is propelled. The lungs also are scarcely ready to perform at once their function, and are often somewhat more of an obstruction than an aid to the blood-current. The pulse in early life, especially during the first year, varies very much, but, as a rule, allowing that the girl's pulse is usually rather quicker than the boy's, the following table represents pretty well what you may expect in males.

TABLE 21.

Age.	<i>Pulse-Rate for Males.</i>	Pulse-Beats per Minute.
Early weeks . . . . .		120 to 140
Until 2d year . . . . .		110
2 to 3 years . . . . .		100
5 to 8 years . . . . .		90

From the eighth year up to puberty the pulse gradually acquires the adult rate. The pulse in children varies greatly under the many nervous influences which are continually affecting it in early life.

Dr. Townsend has also made a record of the pulses taken in the same infants whose temperatures were recorded in Table 20. They, as you see, do not especially correspond with the general averages of Table 21, but are what you may expect in the cases which you happen to see at random.

Clinically I have never arrived at very satisfactory results in my observations on the pulse in infancy. If, however, you care to investigate this subject more thoroughly, I will refer you to the excellent work done on the pulse by Keating and Edwards.

TABLE 22.

Age.	<i>Townsend's Pulse Observations.</i>	
	Quiet.	Crying.
1 day . . . . .	130	158
2 days . . . . .	120	156
5 days . . . . .	152	164
5 days . . . . .		160
6 days . . . . .		152
7 days . . . . .	120	154
7 days . . . . .		160
7 days . . . . .		152
9 days . . . . .	148	
9 days . . . . .	160	180
9 days . . . . .	156	
10 days . . . . .	152	
13 days . . . . .	136	
13 days . . . . .		168
16 days . . . . .	168	172
20 days . . . . .		168

**RESPIRATION.**—The respiration, although quicker in early life than in adults and corresponding somewhat to the pulse, assumes the equilibrium of a later period of development much earlier than is found to be the case with the pulse. It varies with changes of temperature and with excitement, and has its rhythm much more easily affected by diseased conditions than in later life. This table represents fairly well what you will usually meet with on counting the respirations when a child is quiet.

TABLE 23.

Age.	Respirations.	Respirations per Minute.
At birth . . . . .		45
Until the 3d year . . . . .		15 to 40
3 to 5 years . . . . .		25

I should now like you to notice closely this infant (Case 22) which is lying quietly in the nurse's lap.

It is a male, eight months old, and healthy. In the first place, you see that its type of respiration is decidedly abdominal. Counting the respirations by the rise and fall of the ensiform cartilage, which stands out quite distinctly in this case, I find that they vary from 50 to 70 in the minute. They are also, as you see, quite irregular, and by making with a pencil an upward stroke for every inspiration, a downward stroke for every expiration, and a horizontal line for every pause, you will find somewhat the same lack of rhythm that appears in the infant at term, which I described to you in this way in a previous lecture (Lecture II., page 48), and also the rhythm corresponding to that of the infant nine months old which I have already shown to you (Case 17, page 72).

Dr. Townsend has also observed for me the respiration of four cases at the Lying-in Hospital, with the following results :

TABLE 24.

1. Age, 1 hour . . . . .	Respirations, 48 to 56.	(Awake.)
2. Age, 2 days . . . . .	" 30 to 52.	(Asleep.)
3. Age, 3 days . . . . .	" 24, 32, 44.	(Asleep.)
4. Age, 6 days . . . . .	" 28 to 40.	(Crying.)

The respiration in all these cases was very irregular, and both abdominal and thoracic in type. In the baby two days old the respiration was chiefly abdominal.

**HEIGHT.**—The average height of the male infant at term, I have already stated, is, according to a large number of measurements made by Quetelet, Vierordt, and others, about 49.5 cm. (19¾ inches). These figures correspond very closely to those which I have met with in quite a number of infants whom I have myself carefully measured. Insufficient nourishment and improper food, especially as represented in rhachitic children, seem to retard the growth, while, on the contrary, the various fevers seem to increase the activity of growth in length, while decreasing the total weight. In the first three or four months the growth is proportionally rapid to that in the latter part of the first year. In like manner the activity is greater in the first month than in the second, and in the second than in the third, becoming still less in the fourth, fifth, and sixth months.

The average increase for the first month is about 4.5 cm. ( $1\frac{3}{4}$ in.).				
"	"	"	"	" second month is about 3.0 cm. ( $1\frac{1}{2}$ in.).
"	"	"	"	" third to the fifteenth month is about 1 to 1.5 cm. ( $\frac{1}{2}$ to $\frac{3}{4}$ in.).
"	"	"	"	" first year is about 20 cm. (8 in.).
"	"	"	"	" second year is about 9 cm. ( $3\frac{1}{2}$ in.).
"	"	"	"	" third year is about 7.4 cm. (3 in.).
"	"	"	"	" fourth and fifth years is about 6.4 cm. ( $2\frac{5}{8}$ in.).
"	"	"	"	" fifth to the fourteenth year is about 6 cm. ( $2\frac{3}{8}$ in.).

The height is about doubled in the first six years, and at fourteen years the final height has usually been attained to within about one-twelfth. The height at different ages will be shown in comparison with the weight in Table 27 (page 104), when we are considering the question of weight. The growth in height seems to be most active in the spring.

**WEIGHT.**—We now come to the subject of weight in children, the study of which has deservedly attracted considerable interest and scientific research. In quite a number of cases it has been found that the careful and systematic weighing of infants gives us warning of the approach of disease some days before any other symptoms are evident. This point was very clearly illustrated in a case which was under my care at the Infants' Hospital, and to which I shall refer in a later lecture more in detail (Case 279, page 627). This infant entered the hospital to have its food regulated. It was apparently perfectly well, but after a few days the daily weighing showed that it was losing. This loss of weight continued to be the only perceptible symptom for a number of days, when it manifested certain nervous phenomena and died a few days later of *cerebral thrombosis*. We sometimes notice a loss in weight preceding a chronic nutritive disturbance by several weeks, and if the coming disease is an acute one, or is of unusual severity, the loss is often sudden and great. You will therefore readily understand that the careful and systematic weighing of children may be of considerable value in preventive medicine. Thus, if we have noticed that a child has without perceptible cause lost weight, we can, by guarding it from an exposure which in health would not be too great, prevent it from having complications such as of digestion or from cold, and render the coming disease milder in its type and more readily dealt with. In a paper on the Relation between Growth and Disease, by Professor H. P. Bowditch, these changes in weight are especially dwelt upon, and it is apparently shown that this method of determining the onset of the disease is more useful in chronic than in acute diseases, though even in the latter class it is not impossible that the warning may be given in time to be of use, and to merit the term of "danger signal" which has been given to it by Dr. Percy Bolton. Bowditch shows in this interesting table (Table 25) the rate of growth of a girl between two and three years old, and the relation between growth and disease. The figures represent the absolute weight of the child obtained by weighing in the ordinary manner, and then deducting the weight of the clothes.



TABLE 25.

DATE.	Age, in Weeks.	WEIGHT.		
		Kilo.	Lbs.	
1880.				
September 19 . . .	107	11.40	25.08	
October 3 . . . . .	109	11.40	25.08	
November 7 . . . .	114	11.78	25.91	
December 5 . . . .	118	12.25	26.95	
December 12 . . .	119	12.28	27.01	
December 26 . . .	121	11.90	26.18	
1881.				
January 2 . . . . .	122	12.15	26.73	
January 23 . . . .	125	11.80	25.96	
January 30 . . . .	126	11.65	25.63	
February 6 . . . .	127	11.55	25.41	Enlarged cervical glands noticed February 5. Clay-colored dejections February 12-15.
February 13 . . . .	128	11.55	25.41	
February 20 . . . .	129	11.95	26.29	
February 27 . . . .	130	11.75	25.85	
March 6 . . . . .	131	11.94	26.26	
March 13 . . . . .	132	12.15	26.73	
March 20 . . . . .	133	12.20	26.84	
March 27 . . . . .	134	12.41	27.30	
April 3 . . . . .	135	11.91	26.20	Attack of measles beginning April 5.
April 10 . . . . .	136	11.71	25.76	
April 17 . . . . .	137	11.98	26.35	
April 24 . . . . .	138	12.00	26.40	
May 1 . . . . .	139	12.03	26.47	
May 8 . . . . .	140	12.01	26.42	
May 15 . . . . .	141	12.34	27.14	
May 22 . . . . .	142	12.15	26.73	Cold in the head beginning about May 22.
May 29 . . . . .	143	12.09	26.60	

An examination of this table shows that the child, having grown rapidly during the autumn, suddenly, and without any manifest cause, began to lose weight about the middle of December. This loss of weight was irregularly progressive until February 6, when an enlargement of the cervical lymphatic glands was noted, followed a week later by clay-colored dejections. These symptoms yielded to appropriate treatment, and the child again gained weight rapidly until March 27, when a sudden loss of weight occurred, followed by an attack of measles. A subsequent loss of weight in May seems to have been associated with a rather severe cold in the head. We have here, then, a case in which a disorder of nutrition manifested itself by enlarged glands and by clay-colored discharges, but in which these symptoms were preceded for several weeks by a progressive loss of weight. It seems not unreasonable to suppose that this loss of weight was the first symptom of a disturbance which afterwards manifested itself by more unequivocal signs. Even in the case of the acute attack of measles it will be noticed that the loss of weight preceded by at least a week the actual eruption of the disease. You must not, however, suppose that loss of weight in a growing child is in every instance a precursor of actual disease. The weight of a healthy child is liable to oscillation within limits which have not been accurately determined, but it may sometimes amount to ten or fifteen per cent. in a week. Children

lose in weight and regain their loss in a wonderful manner, so easily are they affected by even slight physical disturbances, and so great are their recuperative powers. The weight of boys, as a rule, is somewhat greater than that of girls at birth, and remains greater up to the age of puberty, when the girl rapidly overtakes the boy, surpasses him, and becomes a developed woman very soon, while the boy does not become a man until some years after puberty. This fact you will see exemplified in the table (Table 27, page 104) which I shall presently show you, and which shows that the girls have surpassed the boys in their height at the eleventh year, and in their weight at the twelfth year, when they are found to be taller and heavier than the boys, as is the case also in the thirteenth and the fourteenth year.

The systematic and frequent weighing of infants during the first year of their lives I consider to be of great importance, and far more useful as a means for determining their nutritive condition than any other one method which we know of. For many years I have had the infants at the Infants' Hospital weighed every day as regularly as they are fed, and a glance at the column containing their weights in the various weeks and months gives information as to their general health, and serves as a guide to the changes which it may be necessary to make in their food. The information gained in this way is far beyond what the most careful physical examination could disclose. The weight is, in fact, an index of the nutritive processes to such an extent that it is representative of the child's well-being, while the height gives us information rather as to its cellular activity. I have already stated that the normal average weight of quite a number of infants at term is for males 3250 grammes ( $7\frac{1}{7}$  pounds), and for females 3150 grammes (7 pounds), and I have also stated that many individual cases occurred where the weight was either greater or less than these figures, and yet the infant was healthy. The increase in weight is in direct proportion to the original weight, and if the original weight is small the gain is usually correspondingly small. This, however, is only a general rule, for at times I meet with infants of light weight whose gains are remarkably large, and often surpass those of infants with a heavier initial birth weight. During the first three or four days of life there is usually a loss in weight, and the original weight is in a large number of cases regained only in the second week. If it is not regained by the third week, we should consider that it is a warning that the nutrition of the infant is at fault, and that especial measures should be taken to increase its vitality. This initial loss of weight is usually designated as *physiological*. We must not, however, be misled by this term, or place too much confidence in it, for, as a rule, this initial loss, which often amounts to from 270 to 300 grammes (9 to 10 ounces) can be accounted for only partially by natural physiological causes. The additional loss is evidently pathological, and is to be so regarded, in order that we should endeavor to obviate it, and thus prevent imposing an additional tax on the infant's vitality at a time when any tax whatever should be regarded as serious. Dr. Townsend has



made some interesting investigations on this loss of weight at the Boston Lying-in Hospital, which show that the infants of primiparæ lose about 45 grammes ( $1\frac{1}{2}$  ounces) more than those of multiparæ; also, deducting 45 grammes ( $1\frac{1}{2}$  ounces) as the average loss from removal of the vernix caseosa, the meconium still remaining, that the loss in weight is reduced to 247 grammes ( $8\frac{1}{5}$  ounces) in the infants of primiparæ, and to 222 grammes ( $7\frac{2}{5}$  ounces) in those of multiparæ. The whole loss should include the meconium, which is computed to weigh about 60 to 70 grammes (2 to  $2\frac{1}{3}$  ounces), so that a loss of from 90 to 150 grammes (3 to 5 ounces), which includes also the urine, on the first day, can, in a very general way, be admitted to be purely physiological. Dr. Townsend's figures also show that although the infants of primiparæ lose more and are slower to recover the loss than are those of multiparæ, yet after the second week they overtake and keep pace with the latter. The whole question is simply one of nutrition, it being well known that the milk of primiparæ is somewhat longer in acquiring its equilibrium than that of multiparæ, but that finally it is equally nutritious. It was also found that the presence of the colostrum corpuscles in the milk had something to do with the loss or with the failure to gain. Where the colostrum persisted the infants lost more than when it speedily disappeared. The colostrum should normally disappear in the first week. Where its presence is prolonged into the third week, the infants do not thrive. Townsend cites three cases at the hospital illustrating this point: all the mothers seemed healthy and had plenty of milk.

- (1) Multipara—no colostrum on third day,—infant's loss 8 ounces.
- (2)     "     —colostrum until ninth day,—infant's loss 16 ounces.
- (3) Primipara—colostrum until thirteenth day,—infant's loss 14 ounces.

The average loss in five infants of multiparæ where the colostrum was absent by the fifth or sixth day was 10 ounces.

I am indebted to Evetsky and Foster for much valuable information on this subject, and quote freely from their writings. The whole nervous system of the young child is much more active and excitable than that of the adult. The brain, for instance, besides being fifteen times as large proportionately in the infant as in the adult, increases with much greater rapidity up to the age of seven years than at any other period. In connection, probably, with the constructive labors of the growing tissues is the activity of the lymphatic system. The absorption of oxygen is said to be relatively more rapid than the production of carbonic acid,—that is, there is a continued accumulation of capital in the form of oxygen-holding compounds. The food represents so much potential energy, but it must be converted into tissue before the energy can become vital, and in such conversion a large amount of molecular energy must be expended. The metabolic activity is more pronounced in the infant than in the adult, and is expended not so much on the energy required in the external world as for the rapidly increasing mass of tissue. Another reason for the presence of more active metabolism in



the infant than in the adult is the necessity of rapid molecular interchange to keep up the temperature. The infant having the smaller body, and yet the relatively larger surface (the extent of skin thus being proportionately greater), it loses more heat proportionately than does the adult, and thus suffers more easily from changes of temperature.

Disturbances of the nutritive processes from these conditions very easily arise, and the process of assimilation is much more important than in adult life, for the child's activity implies a greater consumption of nutriment in the form of food or tissue. The child's equilibrium is thus much more easily disturbed than the adult's, and this creates a greater susceptibility to disease and less power to resist external influences. This is well exemplified by the rule that the younger the individual the greater the mortality. There are three times as many deaths in the first half of the first year as in the second half, and a large proportion of those dying in the first half year die in the first month. Of those dying in the first month, death occurs in a large proportion in the first week. A considerable number of the deaths which occur in the early weeks of life, especially in the first week, are from asthenia. These facts are very significant in connection with the child's loss of weight in the early days of life over that which we have just described as being physiological. Lack of sufficient nourishment and an unstable equilibrium are the factors in the problem which represent this early loss of weight. These conditions are enhanced by the state of the mother, who, exhausted by the process of labor, is not able to supply a food for her infant which is adapted to its sensitive and incompletely developed digestive function.

In addition to these manifest causes for loss of weight, we must consider that the new-born infant is much more susceptible to external impressions than when after the first weeks its various functions have become adapted to their new surroundings.

The whole system is stimulated to greater activity of tissue interchange not only by the sudden change of temperature to which the skin is exposed, but also by the change from darkness to light, and from silence to a greater or less degree of sound. This transient early period of life, therefore, is marked by a superactive metabolism, insufficient nourishment, and resulting asthenic conditions which are analogous to starvation. This is represented as a whole by a loss of weight evidently of a pathological character, in addition to that which I have described as physiological. You will, therefore, now understand with what care the newly-born infant should be protected from too great changes of temperature, too much light, and too much noise. The analogy of this statement is found in the sensitive organization and habits of the lower animals. In this way only can the digestive function be made to correspond to such an extent, in the early days of life, to the work which is required of it, as to keep the loss of weight within the physiological limit. Starvation, as is well known, proves fatal primarily not from the amount of food furnished being too little for the processes of

disintegration, but from exhaustion of the nervous system. The endurance of the starvation is in proportion to the capability of resistance of the nervous tissue. This nervous tissue is so highly sensitive and has such great functional activity in the infant, proportionately to the adult, that it needs much more nourishment, and succumbs much more quickly to deprivation from nourishment. Young animals die in a very much shorter time when deprived of food than do older ones from this cause. It is not surprising, therefore, that when the early period of life is represented only by hours and days, the various disturbances which would be of minor consequence at a later period of existence should have a decidedly pathological effect and produce a marked loss in weight beyond the natural physiological loss. The following case, taken from my records of this class, exemplifies the practical bearing of what I have just said.

CASE 23.—A male infant was born December 16 at term. It was healthy and vigorous, and gave no evidence of organic disease. The mother, a multipara, strong and healthy, was twenty-eight years of age. Her other children were living and healthy. On the third day, December 19, the infant had a slight attack of *icterus neonatorum*, which disappeared in twenty-four hours. On the fifth day, December 21, the weather was very cold and bleak, but the infant was taken to church and christened. The church was warm and the infant reasonably well protected from cold, but there were a large number of people present, and an unusual amount of noise. The infant, on being taken home, immediately began to show symptoms of *asthenia*, and on the following day was found to be cyanotic and breathing rapidly, with a subnormal temperature and no apparent organic disease. It died in the afternoon. The *asthenia* seemed to be produced by too early exposure to change of temperature, light, and sound.

As a rule, the average daily gain in the first two months should not be below twenty grammes (two-thirds of an ounce). I have found at the Infants' Hospital that if the gain is less than this the infant, as a rule, is being badly nourished, is sick, or is going to be sick. There are, of course, exceptions to this rule, and I would here also call your attention to the fact that observations of weight including only that of two or three days are very misleading, and that it is the week's weight which gives us the fairest idea of loss or gain. Thus, I frequently find infants showing a daily gain of only five or ten grammes (one-sixth or one-third ounce), or even losing fifteen or thirty grammes (one-half or one ounce) on one day, and then gaining one hundred to one hundred and fifty grammes (three and one-third to five ounces) on the next day. From this you will readily understand that we should obtain from one day's observation too low and on the next day too high an estimate of the nutrition. By the end of the week, however, the weights usually equalize each other, and we have fairly correct figures to guide us. This table (Table 26) shows about what would be expected of the average infant as to weight during the first year. Girls, as a rule, gain less than boys, but this is only if they are of lighter weight. The heavy girls make the same large gains as the heavy boys, but, as a rule, their initial weight is smaller than that of the boys, and they therefore make smaller gains.



TABLE 26.  
*General Figures of Weight.*

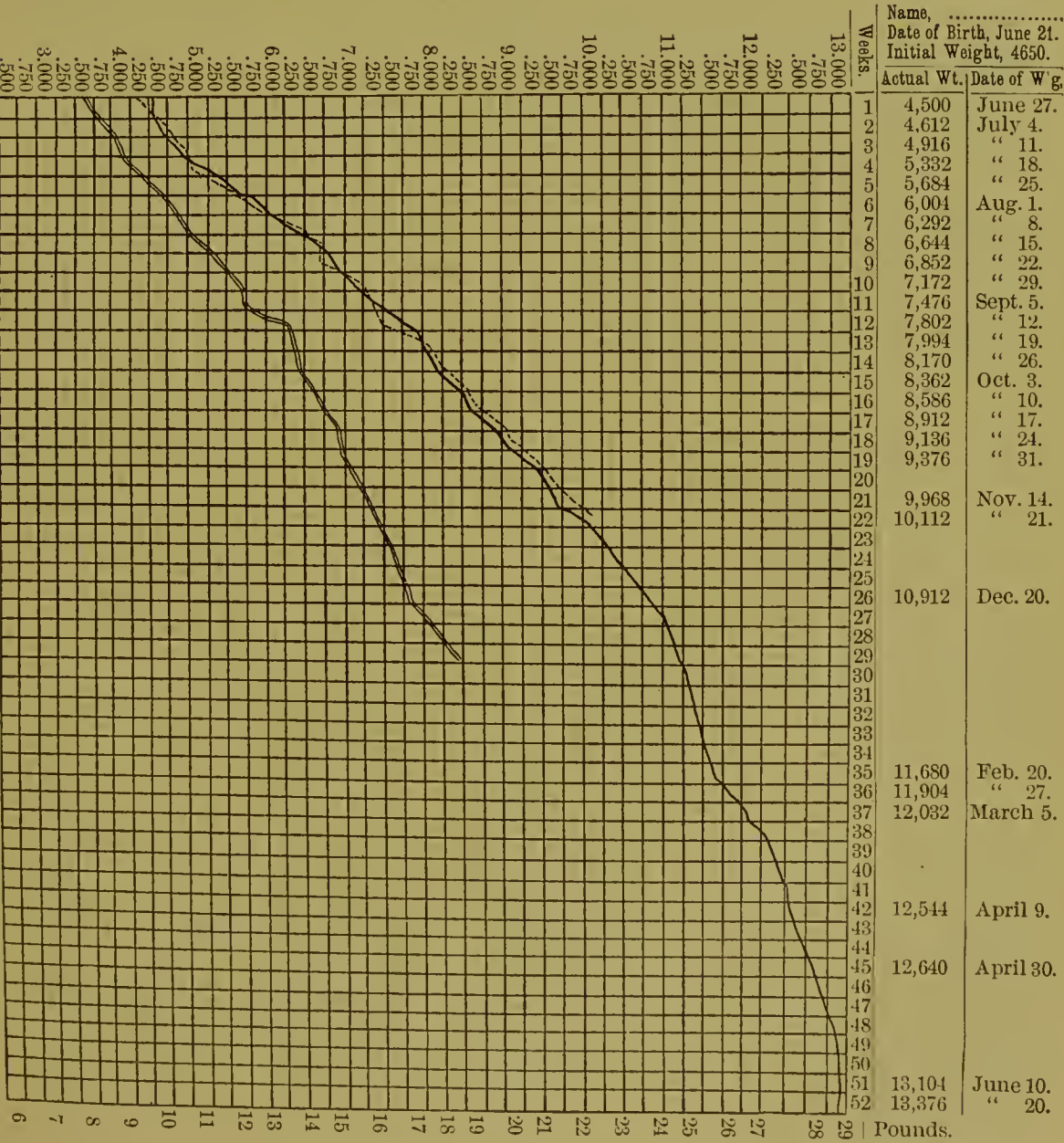
Age.	Weight.		Average Gain per Day.	
	Grammes.	Pounds.	Grammes.	Ounces.
At birth . . . . .	3000 to 4000	6.6 to 8.8		
From birth to 5 months . .			20 to 30	$\frac{2}{3}$ to 1
From 5 months to 12 months			10 to 20	$\frac{1}{3}$ to $\frac{2}{3}$

Age.	Weight.	
	Grammes.	Pounds.
At 1 year . . . . .	9,500	20.90
At 7 years . . . . .	19,000	41.80
At 14 years . . . . .	38,000	83.60

[The above figures are on a basis of 3500 grammes (7.7 pounds) at birth, and of a gain of 30 grammes per day for the first four months and 10 grammes per day for the last eight months of the first year.]

Useful figures to remember are that the initial weight is doubled at five months and trebled at fifteen months; also that the weight at one year is doubled at seven years, and that this weight is again doubled at fourteen

CHART 3.





years. There are, of course, both gains and losses in weight during the year, the weight acting as an index of the disturbances which arise. As a rule, what may be called the line of nutrition rises from the initial weight in the first week, week by week, up to the fifty-second week. A uniform increase is, however, exceptional, on account of the many disturbances, such as from food, the dental periods, weaning, improper hygienic care, and the contraction of disease.

Instances of continual weekly gains during the first year have occasionally come under my notice in both hospital and private practice, and the chart on the preceding page (Chart 3) gives the exact weights of a healthy male infant fed by a wet-nurse for over a year, and will serve as an example of the ideal line of nutrition.

The infant was gaining so regularly that the weighing was omitted in several weeks, which fact is unfortunate, as the weights would probably have shown the same uniform gain. A weekly gain is also shown in this same chart of a male and a female infant, brother and sister, nursed by their mother. The double line represents the boy's weights in the first twenty-nine weeks of his life; and the dotted line the girl's weight for twenty-one weeks.

The question of weight is so intimately connected with that of feeding that I shall reserve showing you the charts recording the daily weights of the infants which for the past ten years I have had an opportunity for studying at the Infants' Hospital, until we begin to investigate the general principles of nutrition. I have prepared this table (Table 27) to show you how at a glance you can determine the average normal height and weight of boys and girls from birth to fourteen years.

TABLE 27.  
*Average Heights and Weights from Birth to Five Years, and of Boston School Boys and Girls, irrespective of Nationality, from Five to Fourteen Years.*

BOYS.				AGE.	GIRLS.			
Height.		Weight.			Height.		Weight.	
Centimetres.	Inches.	Kilogrammes.	Pounds.		Centimetres.	Inches.	Kilogrammes.	Pounds.
49.37	19.75	3.25	7.15	Birth.	48.12	19.25	3.15	6.93
61.87	24.75	6.50	14.30	5 months.	59.12	23.25	6.30	13.86
73.82	29.53	9.54	20.98	1 year.	74.17	29.67	9.00	19.80
84.55	33.82	13.80	30.36	2 years.	82.35	32.94	13.31	29.28
92.65	37.06	15.90	34.98	3 years.	90.77	36.31	15.07	33.15
98.27	39.31	17.27	37.99	4 years.	97.00	38.80	16.53	36.36
103.92	41.57	18.64	41.00	5 years.	103.22	41.29	17.99	39.57
109.37	43.75	20.49	45.07	6 years.	108.37	43.35	19.63	43.18
114.35	45.74	22.26	48.97	7 years.	113.80	45.52	21.50	47.30
119.40	47.76	24.46	53.81	8 years.	118.95	47.58	23.44	51.56
124.22	49.69	26.87	59.00	9 years.	123.42	49.37	25.91	57.00
129.20	51.68	29.62	65.16	10 years.	128.35	51.34	28.29	62.23
133.32	53.33	31.84	70.04	11 years.	133.55	53.42	31.23	68.70
137.77	55.11	34.89	76.75	12 years.	139.70	55.88	35.53	78.16
143.02	57.21	38.49	84.67	13 years.	145.40	58.16	40.21	88.46
149.70	59.88	42.95	94.49	14 years.	149.85	59.94	44.65	98.23

The figures for birth, for five months, and for one year represent my investigations, combined with the figures which I have already shown you. The figures for the second and third years are taken from a series of investigations made by Dr. George W. Peckham, of Milwaukee, in the Report of the Wisconsin State Board of Health for 1882. The figures for the fourth year are approximate averages taken from children of three and five years, as no reliable figures corresponding to the others in the table could be found. The figures from the fifth year to the fourteenth year were taken from Professor H. P. Bowditch's article on the Growth of Children, in the Twenty-Second Annual Report of the State Board of Health of Massachusetts. They represent the average figures of a large number of school-children.

In the preceding table the weights at birth, and in the first, second, and third years, were taken without clothing. The ordinary school-clothes were worn in the weighing from five to fourteen years.

**FEET.**—I have already referred in Lecture II. to Dane's work on the infant's foot at term, and I will now tell you what he has to say on its development, as it is something which cannot be obtained from any other source.

During the first year of life the muscular tone is steadily improving and the foot should show a well-marked arch. In fat babies there may be a large adipose pad formed under the internal arch, such that on taking an imprint of the sole its internal border may appear straight. Even here when the camphor-smoked paper is used there will be a distinct shading, showing that the pressure is much less than in true flat-foot, as is so well shown in this baby with flat-foot (Lecture II., Fig. 14, page 50).

In sickly children, or in cases where for any reason the muscular development is interfered with, the foot will remain in a lax condition, or even of itself fall outwardly into the valgus position. The sexes are alike. Out of eighty-five cases, thirty-five were found to show equally good arches on both feet; in thirty-two the right foot was better formed and in sixteen the left, while seven showed a broken-down or badly-formed condition of the arch.

From the time the child begins to walk there is a distinct breaking down of the internal arch, which in most cases is wholly lost, the two feet suffering equally. For the next year and a half the feet remain quite flat, yet during this period isolated tracings appear in which the arch is never lost. It is interesting to note that such are always girls, and therefore presumably lighter children.

During the third year the arch is slowly rebuilt, one foot improving before the other, and the female's considerably in advance of the male's. When the fourth year has been well entered upon, the feet have reached nearly the adult condition, the two feet are alike, and there is no difference between the sexes.

At the sixth year the adult type of foot has practically been attained. The following tracings represent the average from a series of five hundred and twenty children. Fig. 31 represents female feet from one week to eight years, and Fig. 32 tracings of male feet from two weeks to eight years (page 106).



FIG. 31.



Tracings illustrative of the development of female feet. Ages, 1 week, 3 months, 1, 1½, 2, 2½, 3, 3½, 4, 5, 6, and 8 years.

FIG. 32.



Tracings illustrative of the development of male feet. Ages, 2 weeks, 3 months, 1, 1½, 2, 2½, 3, 3½, 4, 5, 6, and 8 years.



**BONE MARROW.**—In a previous lecture I spoke of the red marrow as characteristic of the bones in early life. The marrow of the bones at a later period of life changes from red to yellow. This change of red marrow to yellow begins, according to Professor Charles Minot, before birth, and progresses in each bone from the centre towards the periphery, or in long bones towards the end. It begins earlier in the distal bones, and then goes on from bone to bone centripetally. Concerning the exact time when these changes take place very little is known, and nothing definite. I will now show you, for comparison with the infant's bone with red marrow already described, this section of an adult bone with its yellow marrow. You see that one is quite distinct from the other. (Plate II.)

**SKIN.**—In the early weeks of life there are two comparatively normal conditions of the skin which may be met with, besides the more common shades of pink and red described in Lecture I. They are called *Icterus Neonatorum* and *Erythema Neonatorum*.

**ICTERUS NEONATORUM.**—Icterus occurs from a number of causes in the new-born infant as symptomatic of disease. There is one form, however, which is of so slight a grade and is characterized by so entire an absence of pathological symptoms that it is usually looked upon as representing a physiological condition occurring in the transition from the intra-uterine to the extra-uterine circulatory mechanism. It is to this condition that the name *icterus neonatorum* is given. It occurs in the first few days of life, and may not entirely disappear for several weeks. The most common time for it to begin is from the second to the third day, and, according to its intensity, the usual time of its continuation is from eight to fourteen days. It is not accompanied by any special symptoms. The conjunctivæ are somewhat tinged with yellow in a certain number of cases, but it does not seem to affect the color of the fæcal discharges or to appear in any quantity in the urine.

Careful examinations of the blood in cases of *icterus neonatorum* fail to show any changes beyond what would be expected in the early transitional stage of blood development commonly found at this age.

This infant (Case 24, Plate II.), a male, was born ten days ago. Its weight at birth was 3400 grammes (7½ pounds). It now weighs 3200 grammes (7 pounds). It was perfectly healthy at birth, and its skin was of the usual pink color which is seen in healthy new-born infants, such as I have already shown you. (Plate I.) On the fourth day of its life the skin began to show a yellow color, which soon became intensified, and, although it is now beginning to fade away, it represents very well the picture of a physiological *icterus neonatorum*. You will notice especially the yellowish-brown color of the abdomen, and the slightly icteric color of the conjunctivæ. The urine in this case is apparently normal, and the fæcal discharges are still tinged with the dark color of the meconium. In another week this yellow color will almost entirely disappear, and the skin will assume the natural pink color of a healthy infant in the first month of life. Later it will become whiter and more like the skin of the older child.

Among the many conditions which might cause this *icterus neonatorum*, the investigations of Birch-Hirschfeld seem to be the most thorough and to

offer the most rational explanation for this condition. This author says that it is difficult to avoid associating the icterus in some way with a disturbance of the hepatic circulation, owing to the transfer of its chief blood-supply from the umbilical vein. This is especially to be seen when we consider the very evident congestion and œdema of the liver, so well described by Weber, which occurs in cases in which the circulation through the umbilical cord is interrupted before the respiratory movements, by their effect on the right side of the heart, afford an adequate compensation.

The vessels in the hilus of the liver are surrounded by a dense layer of connective tissue, which is continued into the organ along the branches of the portal vein. In cases where there is venous obstruction in the liver in consequence of delayed birth this tissue is the seat of much œdema. A broad layer of gray pulpy tissue encloses the vessels and is also seen around the umbilical vein in its diaphragmatic portion, extending also to the gall-bladder. The microscopic appearances of this tissue are those of œdema with more or less abundant accumulation of round cells in the interstices. That this swelling of the tissue must compress the bile-ducts is sufficiently obvious, and Birch-Hirschfeld has found that not only under these circumstances are the bile-ducts distended, but there may be a positive difficulty in squeezing the bile out of the gall-bladder into the duodenum, while in the latter there is a manifest deficiency of bile. In cases where death occurs on the first day of life, a beginning icterus may be distinctly detected, and Birch-Hirschfeld has reported cases demonstrating this condition, and has also observed the gradual increase of the jaundice where life had continued longer. Birch-Hirschfeld has also shown that the presence of the bile-acids may always be demonstrated in the pericardial fluid in fatal cases where this icterus neonatorum was present, whereas they cannot be found in other children who do not present a jaundiced condition. This may be regarded as strong evidence in favor of the hepatogenic origin of *icterus neonatorum*. I shall speak of the graver forms of icterus in a later lecture.

This explanation of the cause of icterus neonatorum must not, however, be regarded as conclusive; for Cohnheim has in a number of autopsies made on this class of cases failed to substantiate the conditions described by Birch-Hirschfeld.

The ordinary bathing of the infant's skin is all that is necessary in these cases of *icterus neonatorum*, and I have never seen any indication for especial treatment of this condition beyond great care in establishing the equilibrium between the food and the digestion.

ERYTHEMA NEONATORUM.—At birth the skin is exceedingly sensitive to external influences, and in every case shows variations in color according to the degree of this sensitiveness, and to the greater or less amount of irritation, whether from temperature or from mechanical causes, to which it is exposed.

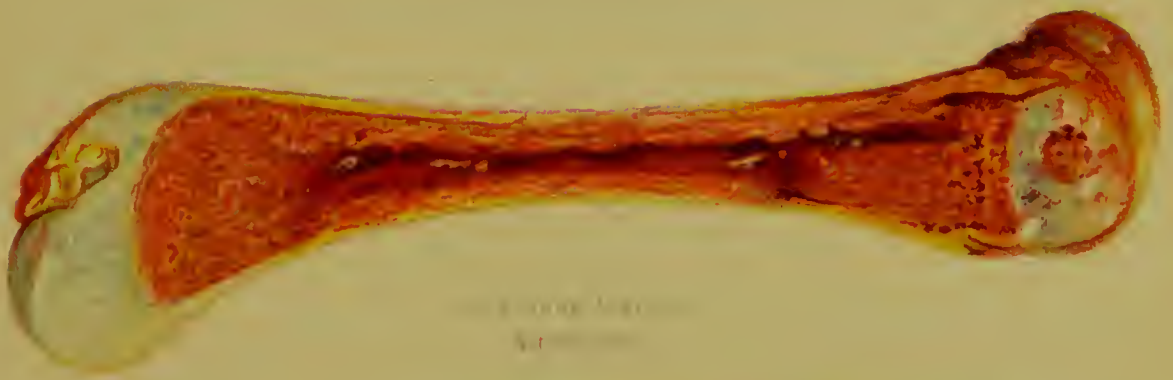
The delicate layers of epithelium are commonly thrown off to such a degree as almost to represent a physiological desquamation, and it is often



# PAGE II



Early & Pyloric Case



Case of Pyloric Stenosis



Case of Pyloric Stenosis



Case of Pyloric Stenosis





several weeks before the normal infantile condition of the skin is reached. In quite a number of cases this natural condition becomes intensified, and we find a uniform redness of the whole skin, which usually appears in the first two or three days of life. In a considerable number of cases this hyperæmic condition of the skin gradually fades away in about a week, and is replaced by the normal pink color which I have already shown you (Case 2, Frontispiece). With many others, however, this red color may be complicated by the icteric condition which I have just shown you (Plate II.), or it may change with many intermediate shades of red and yellow into a pronounced *icterus neonatorum*. These infants, which are respectively five, six, and eight days old (Cases 25, 26, and 27), show very beautifully the combination of these two physiological conditions, while the infant to which I shall now call your especial attention represents a typical case of an uncomplicated *erythema neonatorum* (Plate II., facing page 108).

This infant (Case 28), a female, was born yesterday. It weighed 3000 grammes (about 6 $\frac{3}{4}$  pounds). It is now twenty-four hours old, and its weight is the same as at birth. It began to turn red when it was twenty hours old, and is now, as you see, of a dull but pronounced red color all over its face, head, thorax, and extremities. Its temperature and respirations are normal. The meconium has come away in natural amount. It has begun to nurse, and seems perfectly well.

There are usually no constitutional symptoms in these cases. Where the hyperæmia is very intense a slight desquamation is at times noticed. It is well, therefore, for you to study this rather peculiar red tinge of the skin in comparison with the redness of simple erythema, eczema, erysipelas, and scarlet fever, which I shall show you at a later lecture, and which, owing to the different degree of sensitiveness of the individual skin, may at times simulate erythema neonatorum as well as each other. This possibility of error must be accepted, since these other diseases have been known to appear at so early a period of life, although it is unusual for them to do so. In one instance at least, to my knowledge, a case of scarlet fever, which ultimately proved fatal to another child in the family, was considered by the attending physician, when he first saw it, to be a case of *erythema neonatorum* in the second week of life, and yet eventually he admitted it to be the source of infection of the other members of the family and of the death of one of them.

The application of a simple powder made up from this prescription,

		PRESCRIPTION 1.	
<i>Metric.</i>		<i>Gramma.</i>	<i>Apothecary.</i>
℞ Pulv. zinci oxidi . . . . .	30		℞ Pulv. zinci oxidi . . . . . ʒi;
Pulv. amyli trit. . . . .	120		Pulv. amyli trit. . . . . ʒiv.
M.			M.

with the use of water without soap on the skin, using enough only for cleanliness, until the redness has disappeared, is generally all the treatment that is necessary in these cases.

**CORD.**—The cord should be carefully wrapped in antiseptic absorbent cotton, and no water should be allowed to come in contact with it. It will thus become dry sooner, and will gradually loosen and fall off.

**FUNCTIONS.**—The different functions of the infant vary considerably as to the time of their development, in the same way that is shown by the physical development. It is difficult, therefore, to give exact average figures, and in fact my observation of individual cases has differed so often from these average figures that I can only warn you that you must allow much latitude in stating the proper time for an especial function to develop.

**VOICE.**—During the first year of its life the average infant uses its voice merely in crying to express its discomforts and desires. At about the twelfth month it usually begins to enunciate single words, and in the middle or toward the end of the second year it learns to form short sentences. Children vary very markedly as to the time when they really learn to talk connectedly, but this is usually accomplished by the third or fourth year, though it is somewhat later before they master the details of language, such as the proper use of prepositions.

**MENTAL IMPRESSIONS.**—The infant seldom **SMILES** before the fifth or sixth week, the change of expression of the mouth before that time being usually an indication of some discomfort. In individual cases, however, there is no doubt that the true smile of enjoyment comes earlier, even by the fourth week. The infant usually does not **RECOGNIZE** objects before the sixth or eighth week. Its **HEARING** is soon established. The functions of **TOUCH**, **TASTE**, and **SMELL** I have already told you are apparently more or less developed at birth.

**LACHRYMAL GLANDS.**—The development of the function of the lachrymal glands varies considerably, but the infant will usually be found to shed tears when it is three or four months old. I have, however, known tears to appear as early as the first month. They do not at first come every time the infant cries, so that a number of observations must be made on the same individual before deciding whether this function is present. I have also noticed that even older infants do not shed tears with each crying-spell. These facts are at times quite important to remember, as a suppression of the lachrymal secretion occurs where the infant's vitality has been profoundly affected by disease, and a return of the tears is an indication for giving a favorable prognosis, and often that convalescence is about to be established.

**SWEAT GLANDS.**—The sweat glands are developed at about the third to the fifth week. I have seen an infant in the second week of its life suffering so much as to have its circulation seriously interfered with from the high temperature of a bath-room where it was being bathed, while the nurse who was bathing it was perspiring profusely and was apparently perfectly comfortable. There is, however, a great variation in the time when these glands develop, and at times even in the second week of life I have noticed cases where the head was seen to perspire quite freely. I have already told you



that my observations lead me to think that in certain individuals the function of the sweat glands must be fairly developed at birth.

**SALIVARY GLANDS.**—The saliva is a secretion which is somewhat slow in being established, both in quantity and in its amylolytic property. There is not much flow of saliva in the infant's mouth for the first three or four months of its life, and even when the function of the glands has become so developed that the saliva appears in the mouth in abundance, a comparatively small amount reaches the stomach by being swallowed. It flows out of the mouth over the chin, and until the latter part of the first year, when its amylolytic action has become established, it probably plays but an insignificant *rôle* in digestion. The salivary secretion contains a certain amount of ptyalin, but its diastatic powers seem to be in process of development, and this should indicate to us that this function ought not to be forced into use in digestion until it has become much better established, as towards the end of the first year.

**PANCREAS.**—The amylolytic action of the pancreatic secretion I have already told you is but little, if at all, developed at birth. Towards the end of the first year the function seems to have become fairly well established, and to a degree which will not be harmed by a moderate call upon it for the digestion of small quantities of starch. The pancreatic power of digesting fat also seems to be slight in the early months of life, but to increase gradually and to be well established by the end of the first year.

**BILE.**—The large size of the liver at birth and during infancy is well adapted to the great metabolic activity which is needed for the development of this period of life. The investigations of Jacobowitsch show that the bile in children is poor in inorganic salts, with the exception of the iron salts. It is also distinguished by its small amount of cholesterin, lecithin, and fat, and the smaller percentage of its glycocholic and taurocholic acids, as compared with the bile of later life.

**BLOOD.**—The blood of infants and children is so important a subject and will in the future play so great a *rôle* in the treatment of their diseases that I have thought it better to devote an entirely separate set of lectures to its discussion. I shall, therefore, speak of it later (Division VII.).

**LYMPHATIC SYSTEM.**—The high development of the lymphatic system in early life is very marked. According to Foster, not only are the lymphatic glands largely developed and more active than in the adult (as is probably shown by their tendency to disease in youth), but the quantity of lymph circulation is greater than in later years. The observations of Kramstyk show that particles of fat are very easily absorbed in early life. Brunner's and Lieberkühn's glands are only partially developed in early life; the solitary and agminate follicles are rich in lymphoid tissue.

**THYROID.**—The thyroid body is relatively greater in the infant than in the adult.

**URINE.**—The urine, as I have already told you, is small in amount at birth, and during the first twenty-four hours it is not uncommon to find

# PLATE III.

- A. Intertrigo.
- B. Seborrhœa capitis of infants.
- C. *Amœba coli*. Section of mesocolon. (Leitz oil immersion  $\frac{1}{12}$ , ocular No. 3.)

## *Napkins.*

1. Detritus of uric acid infarction (stain on napkin during early days of life).
2. Meconium.
3. Color of fæces resulting from good human breast-milk.
4. " " " " " " "
5. Crystals of uric acid and urate of ammonium (hedgehog crystals) taken from 10.
6. Substitute feeding. Fat, 2 per cent. ; milk-sugar, 5 per cent. ; proteids, 1 per cent.
7. " " " 3 " " 6 " " 1 "
8. " " " 4 " " 7 " " 1 "
9. " " " 4 " " 7 " " 1 "
10. Detritus of uric acid infarction in excess.
11. Bile-stain on napkin.
12. Color of fæces after bismuth 3 grains every two hours for six doses.
13. " " " " 4 " " " "
14. " " " " was omitted for twenty-four hours.
15. Color on napkin commonly seen, but in this case excessive in amount and pathological from uric acid.
16. Color of "clay-colored" fæces.
17. Color of the change in milk-fed (breast or otherwise) infant's fæces just before or just after they are passed (not necessarily pathological).
18. Pathological color seen in Case 424, page 883.
19. " " " Case 425, page 883.



A



B



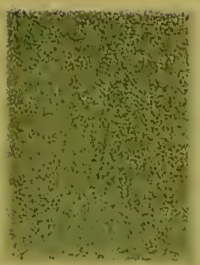
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1

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4



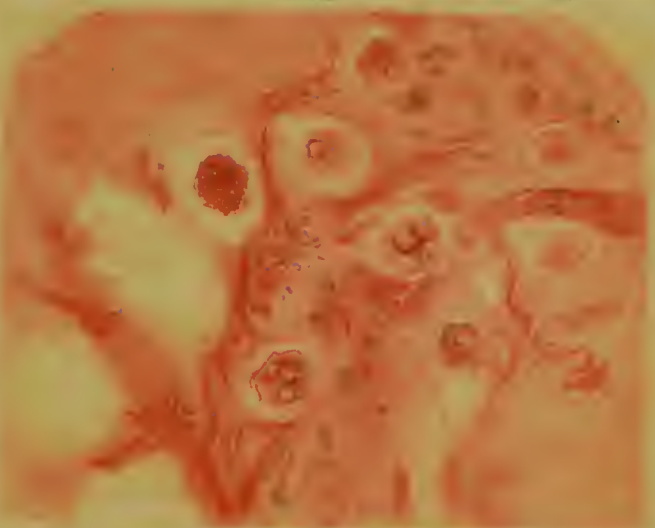
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16

18



17

C.

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little or none passed. The function of the kidney begins quite early in foetal life, and the bladder has been found to be full of urine at birth. The urine which is first passed is usually dark and thick, but it soon becomes of a light yellow color, and is generally slightly acid in its reaction. Its specific gravity (1010 at birth) falls in two or three days to 1003, and by about the fifteenth day is found to be 1006. By the end of the first week and throughout childhood the amount of urine passed in twenty-four hours is relatively greater than in adult life. This in early infancy may be due to the preponderance of liquid food, but is in part the result of the infant's more active metabolism, for the urea is also found to be proportionately increased. According to Foster, the presence of uric and oxalic acid in unusual quantities is a frequent characteristic of the urine of children. It is also stated that the phosphates are deficient, being retained in the body for the purpose of building up the osseous system. The *uric acid infarction*, which I have already referred to, and evidences of which may last for two or three weeks, consists of urate of ammonium (hedgehog crystals), amorphous urates mixed with uric acid crystals, and some epithelial cells (Plate III. 5, facing page 112). The variations in the amount of urine which has been computed to be passed during the early days of infancy and childhood are very great, as the amount in all probability depends very largely on the quantity of liquid ingested. It is well, however, for you to have some general idea of the normal total amount of the urine at different ages when you begin to study the diseased conditions of the kidney.

The difficulties in accurately measuring the amount of urine excreted by very young infants are such that few positive statements can be made as to the quantity. It is sufficient to say that it is about ninety grammes (three ounces) a day for the first few days, and then rises in amount very rapidly.

Rietz states that during the first four days of life the urine contains more or less albumin, and that this disappears at about the seventh or eighth day. It also frequently happens that the first urine that is passed is cloudy.

The following tables (Tables 28 and 29) give approximate figures for infancy and childhood :

TABLE 28.

Age.	Total Urine in 24 hours.
2½ months . . . . .	250-410 c.c. ( $8\frac{1}{3}$ - $13\frac{2}{3}$ ounces) (Pollak).
5 months . . . . .	986 c.c. (33 ounces) (Camerer).

TABLE 29. (Schabanowa.)

Age.	Total Urine in 24 hours.
2- 5 years . . . . .	760 c.c. (25 ounces).
5- 9 years . . . . .	1043 c.c. ( $34\frac{1}{2}$ ounces).
10-13 years . . . . .	1430 c.c. (47 ounces).

It is often convenient to know how much urine is excreted for each kilogramme of body-weight. The following table (Table 30) represents the results of some careful work which has been done on this subject :

TABLE 30. (Vierordt, in Gerhardt's Handbuch.)

Years.	Number of Cases.	Average Body- Weight, in kilogs.	Total Amount of Urine in 24 hours, in c.c.	Number of c.c. of Urine ex- creted for each kilog. of body- weight.
3-5, boys . . . . .	4	13.82	743	53.03
3-5, girls . . . . .	4	14.73	708	48.00
6, boy . . . . .	1	15.5	1209	78.00
7, boy . . . . .	1	22.42	1055	47.06
11, boy . . . . .	1	24.0	1815	75.64
13, boy . . . . .	1	32.69	756	23.12
Adults . . . . .	—	63.0	1700 to 1800	28.00

URINE OF ADOLESCENCE.—It is well to bear in mind, in connection with the conditions of the kidney which exist during the period of development, what has been termed the *urine of adolescence*. At puberty there appears to be a disturbance of the equilibrium of the renal circulation occurring so frequently, and presenting so distinctively the characteristics of a simple hyperæmia, that we are justified in looking upon it as a physiological rather than as a pathological condition.

This physiological congestion of the kidney is probably closely connected with the development and increased activity of the uterine circulation in the female, and with the prostatic and genital blood-supply in the male. The importance not only of knowing that such a condition exists at puberty, but also of bearing it in mind when we are called to treat children who are on the border-line between childhood and adolescence, is too little recognized, and this want of recognition often leads to unfortunate mistakes. Numerous instances of the truth of this statement must arise in the practice of every physician: so that I need refer only to one of a number of cases of this kind which have come under my notice.

CASE 29.—A girl, thirteen years old, was brought to me for advice with the following history. She had always been somewhat delicate, but had never had any special disease, and was considered to be fairly healthy, until she was twelve years old. She then began to grow very fast in height without a corresponding development in weight and general muscular strength. When she was twelve and a half years old the catamenia appeared, and were accompanied by severe pain. This was in November. In December, six weeks later, the catamenia again appeared, and were accompanied by considerable pain and general prostration. The child at this time looked pale and thin, had very little appetite, and was easily fatigued. A physician was consulted, who prescribed strong food, such as meat, a tonic, and gymnasium exercise. This advice was followed implicitly, and the child was made to exercise especially the muscles connected with the abdomen and pelvis three or four times a week at the gymnasium, and by daily home exercise, such as lying on the back and raising the legs. Under this treatment the child rapidly grew worse, and the catamenia did not return in January. The physician then examined the child carefully, with negative results until the following analysis of the urine was made (Analysis 1):

ANALYSIS 1.

March 19.

Specific gravity . . . . .	1035.
Reaction . . . . .	Acid.
Albumin . . . . .	0.05 per cent.
Epithelial and hyaline casts were found.	



The child at this time was thirteen years old. The physician now became much alarmed, and informed the parents that their child had a form of Bright's disease. This statement completely demoralized the whole family, carrying with it as it did to their minds the impression of a fatal issue of the disease. The father, who was just starting on an important business trip involving much money, was so distressed that his business was entirely thrown aside, as he wished to remain near his child. Under these circumstances further advice was sought for, and the case was placed in my hands. A careful physical examination revealed nothing abnormal about the child beyond overgrowth, with a resulting anæmic condition. The urine was sent to Professor E. S. Wood for expert analysis, with the following result:

ANALYSIS 2. (Wood.)

*March 21.*

Color . . . . .	Normal.
Reaction . . . . .	Acid.
Urophæin . . . . .	Normal.
Indoxyl . . . . .	Normal.
Urea . . . . .	Increased.
Uric acid . . . . .	Increased.
Albumin . . . . .	Very slight trace.
Sugar . . . . .	Absent.
Bile-pigments . . . . .	Absent.
Specific gravity . . . . .	1023.
Chlorides . . . . .	Normal.
Earthy phosphates . . . . .	Normal.
Alkaline phosphates . . . . .	Slightly diminished.
Sediment . . . . .	Excess of mucus—a little vaginal epithelium—an occasional hyaline granular and epithelial cast—an excess of renal epithelium—an occasional blood-globule.
Total amount in 24 hours . . . . .	960 c.c. (a little less than 2 pints).

I was enabled from this report to tell the parents that the examination showed simply a slight renal hyperæmia, the very small trace of albumin and the very few casts all pointing towards that condition and against any serious renal disease. The parents' minds were much relieved, but no new treatment was instituted, and, as the child was weak and languid and did not appear to be improving, I decided to have another urine analysis made before giving any further advice.

The next analysis showed the following conditions:

ANALYSIS 3. (Wood.)

*April 4.*

Color . . . . .	Normal.
Reaction . . . . .	Acid.
Urophæin . . . . .	Normal.
Indoxyl . . . . .	Increased.
Urea . . . . .	Increased.
Uric acid . . . . .	Much increased.
Albumin . . . . .	Very slight trace.
Sugar . . . . .	Absent.
Bile-pigments . . . . .	Absent.
Specific gravity . . . . .	1027.
Chlorides . . . . .	Normal.
Earthy phosphates . . . . .	Increased.

Alkaline phosphates . . . . .	Normal.
Sediment . . . . .	Much calcic oxalate — much vaginal epithelium and uric acid crystals—excess of renal epithelium — a few blood-globules—an occasional hyaline and granular cast of small diameter with renal cells and blood adherent.

This analysis showed the urine to be so concentrated that the indications for treatment were very evident.

The child was not allowed to go to school or to the gymnasium. She was made to rest in bed for several hours twice a day. Her diet was largely milk in considerable quantity, meat especially being withheld. She was also made to drink freshly distilled water, 250 c.c. (about eight ounces) once in six hours. She was allowed to take a slight amount of exercise out of doors, but to a very limited degree.

This treatment, so radically different from what she had previously received, was instituted on the ground that while there was no organic disease of the kidneys, yet the hyperæmic condition was so pronounced as to show that the renal tubules were being kept in a condition of chronic irritation to a considerable degree. This irritation was so prominent a factor in the girl's generally debilitated condition that it became for the time being of primary importance. The causes for the irritation were very evident. The catamenia were just being established; accompanying this was the irregular and varying congestion of the pelvic organs originating with the uterus and ovaries, and extending to the kidneys. In addition to this was the adolescent condition so common in children growing too rapidly for their general nutrition. The girl had been made to exercise the very muscles whose exercise would naturally tend to increase pelvic congestion, and was fed largely on meat, which would not tend to lessen the renal congestion. The indications for treatment were evidently rest for the pelvic organs and dilution of the irritating concentrated urine which was passing through the renal tubules.

Under this course of treatment the child began slowly to improve. She became less anæmic; her appetite increased, and was less capricious; she began to gain in weight, to sleep well, and to have more strength. On April 11 another analysis was made by Professor Wood, with the following result :

ANALYSIS 4. (Wood.)

*April 11.*

Color . . . . .	Normal.
Reaction . . . . .	Slightly acid.
Urophæin . . . . .	Diminished.
Indoxyl . . . . .	Normal.
Urea . . . . .	Slightly diminished.
Uric acid . . . . .	Increased.
Albumin . . . . .	Very slight trace.
Sugar . . . . .	Absent.
Bile-pigments . . . . .	Absent.
Specific gravity . . . . .	1015.
Chlorides . . . . .	Normal.
Earthy phosphates . . . . .	Normal.
Alkaline phosphates . . . . .	Diminished.
Sediment . . . . .	Excess of mucus and renal cells — few blood-globules — one hyaline cast detected (after a search of more than an hour) —vaginal epithelium.

This analysis showed such marked improvement that it was evident that we were dealing with an exaggerated physiological rather than with a pathological condition, and that our treatment was a wise one. I think it may be of interest to you to follow the gradual improvement which took place later, and which resulted in complete recovery in about one year from the time when the albumin and general renal irritation were first noticed. This improvement is shown in the following table :

TABLE 31.

Analysis.	May 2.	May 6.	June 7.
Albumin . . . . .	Slight trace.	Slight trace.	Very slight trace.
Specific gravity . . . .	1008	1033	1018

The sediment was very similar in all these analyses, and consisted of mucus and of vaginal epithelium, a little sceondary ealcic oxalate, and an occasional hyaline cast and blood-globule.

A final analysis (Analysis 5), made January 29, enabled me to give the following satisfactory report, namely, that there was no evidence of any renal disturbance whatever, and that the urine was normal in every way.

ANALYSIS 5. (Wood.)

*January 29.*

Color . . . . .	Normal.
Reaction . . . . .	Acid.
Urophæin . . . . .	Normal.
Indoxyl . . . . .	Normal.
Urea . . . . .	Normal.
Uric acid . . . . .	Normal.
Albumin . . . . .	Absent.
Sugar . . . . .	Absent.
Bile-pigments . . . . .	Absent.
Specific gravity . . . . .	1020.
Chlorides . . . . .	Normal.
Earthy phosphates . . . . .	Normal.
Alkaline phosphates . . . . .	Normal.
Sediment . . . . .	Vaginal epithelium and mucus.

**INTESTINAL DISCHARGES.**—The contents of the intestine continue to be mixed with meconium for three or four days or a week, the longer time being when the infant is weak and does not nurse well. After this time the infantile discharges, which have a characteristic appearance as distinguished from those of the older child, appear. It is especially necessary for you to familiarize yourselves with their characteristics, as they are an important guide to the proper feeding of the infant and are an index showing whether the food is properly digested and assimilated. When the nutriment is milk, with the percentages of its different elements corresponding to what is normally found in good average human milk, the discharges are of a golden yellow color, smooth, unformed, of medium consistency, showing a large proportion of water, and sometimes changing on exposure to the air to a greenish yellow. They as a rule contain undecomposed bile-pigment and bile-salts, while the older child's and the adult's discharges do not contain the bile undecomposed. The amount of fæcal discharge in the first day of life is about forty-five grammes (one and one-half ounces), and increases in the



following days to fifty grammes (one and two-thirds ounces). It consists of mucus, fat, epithelial remains, and a slight amount of albuminoid material. In early infancy there are from two to four discharges daily. As the child grows older there are two and finally one in the twenty-four hours. They do not lose their yellow color until amylaceous or albuminoid food is given, when the different shades of brown begin to appear; they are not formed until something besides milk is swallowed. Starting at birth with the sterile meconium, infection by the mouth and rectum quickly occurs, and in a short time almost any form of bacteria may be found in the discharges, but chiefly such putrefying forms as *Proteus vulgaris* (Jeffries). With the suckling of the infant and the substitution of the refuse of the milk and the secretion of the digestive tract for the meconium, a sharp transition occurs. Instead of the generally distributed forms, causing decomposition, only two kinds of bacilli are now regularly found, the *Bacillus lactis aërogenes* and Brieger's bacillus, the first chiefly in the upper parts of the intestine, the second in the lower part. When the infant begins to take a mixed diet, quite a number of forms of bacilli appear, among them the *Streptococcus coli gracilis*, the putrefying green fluorescing, a tetrad coccus, and several kinds of yeast. The color of the infantile intestinal discharges when the nutriment is milk alone, whether human or animal, seems to depend somewhat on the percentage of fat, as you will see by examining these napkins with discharges on them produced by milk of varying percentages (Plate III., 3, 4, 6, 7, 8, 9, facing page 112). The consideration of the faecal discharges of the infant is so closely connected with the subject of infant feeding that I shall leave anything further which I have to say about it until we begin to consider that important branch of our medical studies.

We have now, gentlemen, studied the principal anatomical and physiological facts concerning infants and children which will be of practical use in aiding us to diagnose and treat their diseases. Before beginning the study of these diseases I should like to present for your inspection some actual illustrations of normal infants and children. I have explained and shown to you in a general way the normal condition of the external portions of the body, and also what it contains.

**INFANTILE SKELETONS.**—It may aid you to remember what I have said if you will also first examine these two skeletons. One (Fig. 33) is the skeleton of an infant at term. The other (Fig. 34) is the skeleton of an infant at nineteen months.

You see in the younger subject the large head in proportion to the small thorax, and the lack of development of the face in comparison with the head, which is very evidently due to the rudimentary development of the jaws. You will also notice the widely open anterior fontanelle. On examining closely the sternum you will see that it is not in one piece, as in the adult, but that the centres of ossification with the intervening cartilaginous connections, which I have already described in a previous lecture (Lecture III., page 71), are well marked. You will also notice what I have not

FIG. 34.



FIG. 33.



Infant at term, showing large head, large anterior fontanelle, small thorax, cartilaginous sternum, tilted pelvis, and bow-legs.

Infant at 19 months, showing large head, small anterior fontanelle, ossification of sternum, tilted pelvis, and straight legs.

Warren Museum, Harvard University.



CASE 30.



Infant in early hours of life, having head and back supported.  
(Page 119.)

CASE 31.



Infant 2½ months old, supporting its own head.  
(Page 119.)



CASE 32.



Infant 8 months old, sitting alone. (Vide page 120.)

CASE 33.



Infant 10 months old, creeping. (Vide page 120.)

CASE 34.



Infant 12 months old, standing. (Vide page 120.)

CASE 35.



Infant 15 months old, walking. (Vide page 120.)

referred to before in speaking of the pelvis, how it is tilted forward, as compared with the adult's, and how small and contracted it looks. You will observe that the legs are not straight, as in the older child, but show decided bowing of the tibia and fibula. This characteristic condition of the legs in intra-uterine life is present at birth and continues for some months, the bones usually becoming straight by the time that the period of walking has been reached. In this skeleton of an infant nineteen months old, you see that the legs have developed naturally in their growth and are straight. The pelvis still tilts somewhat, but is evidently less contracted, or rather has begun to enlarge. The thorax has broadened in comparison with the head, and the cartilaginous sternum has become to a large degree bone. The head is still large proportionately to the face, although the jaws have developed considerably beyond what is seen at birth. The anterior fontanelle is, as you see, quite small in comparison with the fontanelle of the new-born infant.

These are the chief characteristics of the infant's and child's skeleton, and you will now appreciate this series of infants and children which I have carefully selected to impress upon you the ages at which the various stages of physical development should naturally be found.

**NORMALLY DEVELOPED INFANTS.**—You must not consider this exhibition of healthy infants too trivial for your closest study. I believe that one of the greatest drawbacks to the proper appreciation of the kind of knowledge which is needed to examine children successfully and intelligently when they are sick, is the lack of precise facts concerning healthy children. To know at a glance whether it is normal for a child not to sit alone or not to stand alone,—to understand its childish actions, whether in creeping or in walking,—these are data which will be of infinite use to you in your nursery practice. I therefore do not hesitate to occupy a certain amount of time in showing you these infants whose physical development and strength represent about what you will meet in a large number of average individuals at these especial ages.

This infant, a few hours old (Case 30), is, as you see, absolutely *unable* to sit up or to *hold its head up*. The swollen condition of the face which is so frequently seen during the early hours of life after a prolonged labor is well exemplified here, and will pass away naturally by to-morrow. When the head is not supported, it falls in any direction on the thorax. You must, of course, impress upon the nurse that care should be taken to support the head gently as well as the back in lifting and carrying the infant at this age, and until the muscles have developed to a degree which will render it possible for the infant to support its own head, or until, as is still more important to remember, it has learned to co-ordinate sufficiently to make use of these muscles. The time when the infant begins to sustain its own head varies considerably, certain individuals being decidedly preeocious in this respect, while others, without showing any sign of disease, are much later in sustaining their heads than is the case with the average infant. From *two to three months* is about the time when the normal infant, according to my experience, *sustains its head* without assistance, although this is usually done in a very vacillating way up to the fourth or fifth month.

This infant (Case 31) is two and one-half months old. It is apparently normally developed as to weight, height, and general growth, and, although it cannot sit alone, and has to have its back supported, it holds up its head quite steadily.



We have now arrived at a period of growth when the infant can be put on the floor without having to be held by the nurse. This is usually from the *seventh to the ninth month*.

The nurse has just undressed this infant and placed it on the floor (Case 32), so that you can see it from all points of view. The infant is *eight months* old, and is normally developed. She, as you see, *sits alone perfectly well*, and can be allowed to amuse herself on the floor without fear of her falling over.

The next infant which I shall have brought in to show you is a little more advanced in its physical development, as it is ten months old. While the one at eight months (Case 32) can sit very well, you see that it cannot as yet move about the floor, and in fact does not attempt to do so; but watch how this active infant, *ten months old* (Case 33), as soon as you place it on the floor, turns over on its hands and knees and moves across the floor, rather awkwardly, perhaps, and not very fast, but it certainly can be said to *creep*. It is natural for the average infant of from ten to twelve months to move about in this way. The locomotion of infants at this age, however, is not always on their hands and knees. Many individuals never creep, but their first efforts in progression are represented by sitting on the floor and dragging themselves along with one leg.

Now we will see what this next infant, which is *twelve months* old (Case 34, facing page 119), can do when we place it beside the others.

This infant has arrived at a period of development when it is strong enough to pull itself up and *stand by a chair*, and you see that it immediately performs this feat, and is evidently very proud of the accomplishment.

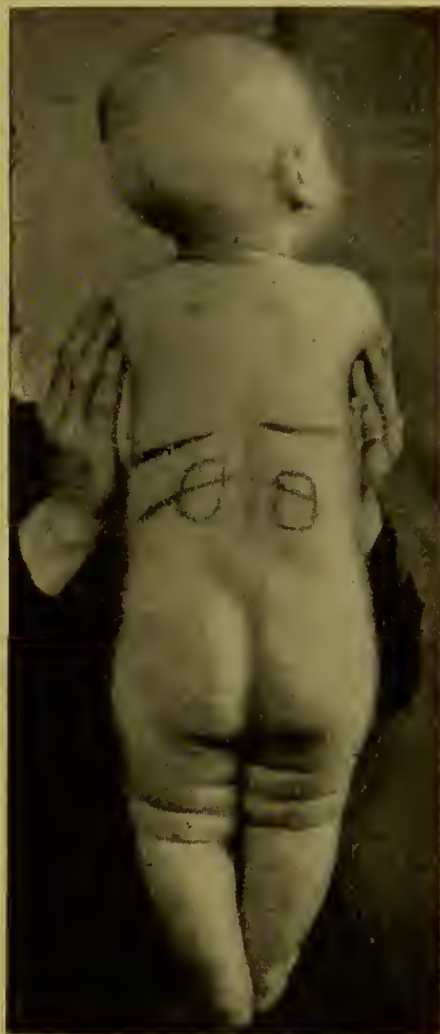
Finally, here is another infant, fifteen months old (Case 35, facing page 119), and normally developed, as you will notice if you carefully examine it. The head proportionately to the adult's is still large. The thorax is well formed, with the natural curves of the back, and the legs are straight. It can walk very well, and although it is rather averse to performing for your benefit and is crying, still you see that it can go across the floor to its mother perfectly well without falling. The age at which the average infant walks of course varies, and many infants never attempt to creep, but begin to walk before they are twelve months old. The average infant, however, *walks from the twelfth to the fifteenth month*.

**TOPOGRAPHICAL ANATOMY OF THE EARLY PERIODS OF LIFE.**—I have already spoken of the importance, for purposes of diagnosis, of recognizing the fact that the organs differ in the space which they occupy in the body according to the stage of development of the child. Well-marked periods are thus shown to exist by physical examination as well as by anatomical research, and the results of these different methods of investigation are found to correspond. I have always found that a careful consideration of the period of development is of the first importance when beginning to make a diagnosis of disease, especially of the heart and lungs. The large size of the liver in infants and the comparatively greater proportionate size of the heart to the lung in the middle years of childhood are striking instances of the truth of this statement, and should warn us that more than ordinary care should be employed in diagnosing a pneumonia of the right lower lobe behind in infancy, or a dilated heart in childhood. Three periods of growth are of especial significance in this connection: 1. The development of the organs in the first year, especially in the first half of the year. 2. A period occurring during the fourth, fifth, sixth,

seventh, and perhaps eighth and ninth, years. 3. The later years of childhood.

To represent the first period I have taken this infant (Case 36), seven months old and normally developed, and I have outlined in black the principal points both in front and behind which will be useful for you to remember when making a physical examination at this age.

CASE 36.



Normal infant seven months old.

First look at him in front. The plain dark lines have followed the lower margin of the ribs and the outline of the ensiform cartilage and manubrium. To the left of the lower part of the left parasternal line you will notice a small curved line. This represents the absolute dulness of the heart. The relative dulness is very slight, and indeed almost imperceptible even on light percussion over the sternum. This area of dulness can almost be covered by the end of the finger used for percussion. It is bounded by the fourth rib or third interspace above, and is just within the mammary line. There is very fair resonance under the whole length of the sternum. The interrupted lines represent the upper and lower borders of the liver. There is not much to say about the upper line, but the lower one is interesting and instructive as illustrating the large size of the liver in early infancy, and you see how little of the stomach, which is here represented by a dotted line between the edge of the liver and the left border of the ribs, is to be reached by percussion. The stomach is, of course, in this infant, empty. When full, it comes out much further under the edge of the liver. This general idea of its position, however, is very important when we come to consider cases of improper feeding where we have to determine whether we have a dilated stomach to deal with. The broad black line just above the level of the umbilicus



marks the transverse colon, which in infancy has a relatively low position. The cæcum, which is marked by a black circle, stands, as you see, high in the abdomen, near the anterior superior spine of the ilium. I have also outlined the upper piece of the sternum and indicated the clavicle and first rib. On looking at this infant's back you will see that I have marked the lower borders of the thorax, the kidneys, and the lower borders of the lungs. The left kidney is decidedly higher than the right at this age. While the lower border of the lung on the left comes down as far as the tenth rib, the corresponding border of the right lung, owing to the large size of the liver, descends only as far as the ninth rib.

I shall now show you a child in the second period of growth (Case 37). In this middle period of childhood the heart has developed more rapidly proportionately than the lungs, and takes up more space in the anterior portion of the thorax.

CASE 37.



Normal development at six years.

This boy, six years old, and properly developed for his age, presents certain points of interest which differ from the infant and the adult, and which should be carefully taken into account when we are making a physical examination at this age. You see I have first marked the manubrium, indicating the clavicles, the first and second ribs, the ensiform cartilage, and the lower borders of the thorax. The area of cardiac dulness is far greater than in this infant (Case 36). This dulness should, so far as the sternum is concerned, be determined by light percussion directly over the sternum from above downward. In this way we can detect the change in the percussion note over the lower part of the sternum



better than by percussing from the lung to the sternum, since the former is so much more resonant that the sounds are more difficult to distinguish and are often misleading. The upper resonant part of the sternum, on the other hand, presents an excellent opportunity for comparison, and brings out the delicate shades of sound which are needed in getting the relative dulness. This relative dulness, however, is usually pronounced under the lower part of the sternum in this period of development, and you hear as I percuss to the left how it shades off into the absolute dulness of the precordia. Absolute dulness under the sternum, unless depending on pathological conditions, is rare even at this age, when it is also rare not to have this physiological relative dulness. In this period the dulness of the heart extends higher in the left parasternal line than at any other time of life. The lower border of the third rib usually marks the upper border of the absolute dulness, which extends also to the left parasternal line and keeps well within the mammary line. The relative dulness, on the other hand, reaches as high as the lower border of the second rib. It then passes to the right under the upper third of the sternum, descends obliquely to the fourth right costal cartilage, and then keeps closely to the right parasternal line.

To the left it extends well out to and perhaps a little over the mammary line. The area of dulness in this special boy I have outlined where as I percussed his precordia you heard a marked absolute dulness between the mammary and left parasternal lines gradually shading into the marked relative dulness of the lower third of the sternum. You will notice that this is a far different result of percussion from that which is found in the adult, and in this infant (Case 36), where, as I have shown you, there is no dulness under the sternum, and the absolute dulness rises only as high as the fourth costal cartilage in the left parasternal line, and the relative dulness only to the third interspace. The relative dulness also extends only as far as the mammary line. The impulse of the heart is usually found a little higher in infants and in young children, irrespective of these periods, than in older children and in adults.

You will next notice that a much smaller space is occupied at this age by the liver than in infancy. This I have indicated by the double line, which rises as high as the fifth rib in the mammary line, and to the attachment of the sixth or seventh right costal cartilage to the sternum. The dotted line of the stomach, on the other hand, occupies, as you see, a much larger space than in the infant. The line of the transverse colon stands proportionately higher, the cæcum rather lower. On examining the back, you see the lower border of the right lung is still a trifle higher than that of the left, and comes to about the upper border of the tenth rib, while on the left side it extends to the lower border of the same rib. At this age the liver has diminished in size relatively to such an extent that the difference of the position of the lower borders of the lung is but slight.

The kidneys are about on a level on both sides. I have also indicated as landmarks for your study the first and twelfth dorsal vertebræ. You see that this child is passing through transitional stages of physical development, and is gradually approaching the adult type of perfected growth.

This perfected growth, so far as the topography of the organs is concerned, is reached in the last years of childhood and at about the age of puberty. The organs of the child seem at this age, although they have not yet acquired their complete growth, to present for purposes of percussion the outlines which we are accustomed to see in the adult, with the exception possibly of the position of the cæcum.

This normally developed boy (Case 38, page 124), twelve years of age, illustrates remarkably well the relative topographical correspondence of later childhood and adult life.

I have, as in the boy of six years (Case 37), outlined the manubrium, clavicle, first and second ribs, ensiform cartilage, and the lower borders of the thorax. The curved line passing up the left parasternal line to the fourth rib and keeping within the mammary line marks the absolute dulness of the heart, and corresponds to the topography of the adult's heart. The upper line of the liver is, you will notice, found to be about at the level of the

fifth rib in the mammary line, and does not extend beneath the lower border of the ribs, but is just below the tip of the ensiform cartilage. The dotted line represents the stomach. The spleen has its upper border at the ninth rib, and its lower portion comes down as far as the lower border of the eleventh rib. The cæcum you will notice is marked in the upper

## CASE 38.



Normal development at twelve years.

part of the right groin. The transverse colon is about midway between the stomach and the umbilicus. Looking at this same boy from behind, you will see that I have marked his kidneys and the lower borders of his lungs in about the same relative position as occurs in the adult. I have also indicated the first and twelfth dorsal vertebræ.

These representatives of the normal development of important periods of life have not only been carefully mapped out by myself by percussion and in accordance with the anatomical knowledge which we possess on this subject, but have also been verified by Professor Dwight, who has examined each child carefully and has satisfied himself that my marking is correct. I shall at present say nothing more about these various stages of development, the knowledge of which I hope you have now mastered sufficiently to utilize in connection with the subjects to which I shall next direct your attention.

## DIVISION III.

### HYGIENE OF THE NURSERY.

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#### LECTURE V.

THE NURSERY.—INTERTRIGO.—SEBORRHŒA CAPITIS OF INFANTS.  
—CLOTHING.—FEET AND SHOES.—SLEEP.—OUT-DOOR AIR.—NURSERY-MAIDS.—SCHOOL.—IMPORTANCE OF CORRECTING DEFECTS OF POSTURE.—VACCINATION.

WE have studied the infant at term with regard to its normal anatomy and physiology. We have also examined it at different periods of its growth up to the age of puberty.

I must now, before undertaking to explain and to show to you the various diseases of early life, impress upon you the importance of a knowledge of the care of the infant and child in health. I am accustomed to place what I have to say on this subject under the title of "Hygiene of the Nursery." It is essentially in the nursery that we should study the healthy child, as the nursery is its home, where it feels most at ease and behaves in the most natural manner. The general hygiene of the child is represented in its nursery, and we should therefore by our knowledge and advice so direct these questions of nursery hygiene as to give this sensitive, easily impressionable young human being the best opportunity to develop into a healthy and vigorous adult.

**NURSERY.**—We cannot, of course, in every case procure for the child the surroundings which are best for it, but we can at least impress on the parent what these surroundings should be, and how important they are for the general health of the child. The nursery should be high from the ground and out of reach of the dampness which arises towards the latter part of the day.

**SUN AND WINDOWS.**—It should have a sunny exposure and large windows high enough from the floor to avoid having the younger children continually pressing their faces against the glass to look out, and thus frequently catching cold from the little currents of air which penetrate most window-casings. The mothers often overlook this simple manner of catching cold, and wonder how their children, who are so closely watched, could have contracted the catarrhal conditions which you will be summoned to treat.



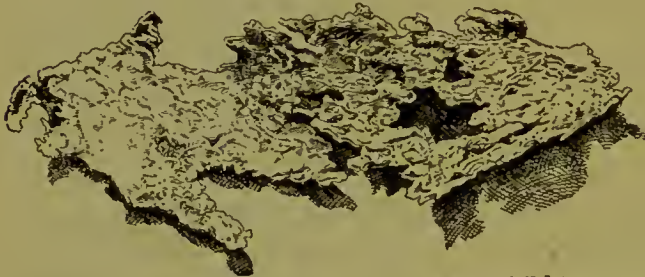
**PAPERS AND CARPETS.**—In my opinion it is much better not to have a paper on the walls or a carpet on the floor. Young children are very susceptible to inhalation poisons, and to organisms of all kinds. Many a case of anæmia, naso-pharyngeal catarrh, and stomatitis ulcerosa has in my experience apparently arisen from arsenic in the paper. Dust also, with its multitude of organisms, which with the most careful sweeping it is impossible to get rid of, is another source of irritation to the respiratory tract. I shall speak of arsenic in the wall-paper later, but here merely state, in support of what I have just said, that very minute amounts of arsenic appear to affect young children, and that the paper itself is a receptacle for micro-organisms which are difficult to eradicate.

**PICTURE-MOULDINGS.**—It is advisable not to have any picture-mouldings on the walls, as they are a place for dirt to gather which it is impossible to remove properly.

**FLOOR.**—There should be as few cracks as possible in the floor, and it should be smooth, so as to be easily cleansed. The floor, however, should not be highly polished, for children frequently fall while playing, and sometimes quite severe accidents occur in this way. I have known of one little boy four years old (Case 39) who broke his arm by simply slipping and

falling on the floor. It is too often the case that blows and resulting injuries are overlooked because it is thought that all children naturally fall and strike their heads. This little boy, two years old (Case 40), fell on his nursery floor six months ago. Nothing especial was noticed at the

FIG. 35.



Sequestrum from frontal bone, natural size. Child two years old.

time, but one week later a swelling appeared on the right frontal bone, and later three small ulcers were noticed in the same locality. The child was brought to the hospital, and Dr. Augustus Thorndike examined and removed this sequestrum,  $6\frac{1}{2}$  cm. ( $2\frac{5}{8}$  inches) long, exfoliated from the right frontal bone and extending from the temple and line of the hair backward, including a little of the sagittal suture.

**WALLS AND CEILING.**—I prefer the floor, the walls, and the ceiling to be painted. Not only can they then be frequently washed and scrubbed, but when the child happens to have any of the contagious diseases, the whole room can so easily be disinfected that it saves much trouble and expense.

**RUGS.**—A rug is desirable in the middle of the room. It should never be an antique; in fact, it is better to have new, simple carpet rugs. The rug should not be too large nor too heavy to be frequently taken out into the open air and thoroughly beaten.

**BED.**—The child's bed should be iron, painted so that it can be carefully

cleansed by wiping, and its sides, as the child grows older, should always be kept high enough, by some simple contrivance, to prevent the child from climbing over them. As few hangings and useless curtains, with which the mother is usually so desirous of draping the bed, should be used as possible.

**Pillow and Mattress.**—The pillow and mattress should be of hair, and the latter should be protected by a rubber sheet and aired thoroughly every day. Especial precautions should be taken that the child does not kick off the clothes at night. It is well for the nurse's bed not to be close to that of the child. This entails a little extra trouble on the nurse's part, but her breath is not a healthy pabulum for the child's lungs, which require fresh, pure air of their own.

**CLOSETS AND DRAWERS.**—The child should have its own closet and its own drawers. The nurse's belongings ought to be kept in a separate room. The closets and drawers should be cleansed at least once a week.

**FURNITURE.**—There should be sufficient furniture in the room for comfort, but stuffed furniture should be avoided. As little as possible that is complicated or cumbersome should be kept in the child's nursery.

**CURTAINS.**—Only simple muslin curtains, which can be washed, should be used at the windows.

**HEATING AND VENTILATION.**—The heating and ventilation of the nursery are of great importance. The child requires pure, warm air. The temperature of the room can vary somewhat according to the climate, but, as a rule, the average should be from  $18.8^{\circ}$  to  $21.1^{\circ}$  C. ( $66^{\circ}$  to  $70^{\circ}$  F.). The open wood fire is best both for the character of the heat which it gives, and for its value as a means for promoting ventilation.

**DRAUGHTS.**—We must take into consideration the currents of air in the nursery, so that the mother, understanding the atmospheric conditions which surround her child, can give the simple directions, which she has learned from us, to the nurse. This is by no means an unnecessary precaution, for one of the worst cases of rheumatism in the hip-joints (Case 41, Division XVIII., Lecture LIII., page 1085) which has come under my notice was that of a child two years old who was allowed to sit on the floor with its back to the open door, and directly in a line with the open fireplace. The direction of the currents of air between the doors, windows, and open fireplace is admirably and scientifically described by Mr. John Pickering Putnam in his valuable work entitled "The Open Fireplace," and I have represented the direction of the cold-air current in a picture (Fig. 36, page 131) which I shall presently show you. If the child is much on the floor, a sheet can easily be placed over the cracks of the door; and plain white sheets are always the best articles for screens or portières.

**WINDOW VENTILATORS.**—A plain piece of wood the width of the window, about 10 cm. (4 inches) high, and made to fit closely to the window-sill, is the best ventilator, but is rarely needed where a wood fire is burning in the room. The upper sash can also be lowered for a few inches if more air is needed.



**TOYS.**—Remember that a child puts everything that it gets hold of into its mouth, so be careful not to allow it to have toys with colors that can be soaked off by its saliva, which would perhaps poison it. Toys also which are made of woollen materials or of feathers should be avoided, as particles easily come off them.

**SCALES.**—The weight of the infant is so important, as I have told you in a previous lecture (Division II., Lecture IV., page 97), that I consider properly adjusted scales an important part of the nursery equipment. The scales which are usually provided are, as a rule, very inadequate for the minute and daily weighing, the results of which are at times of such great assistance to the physician in the management of the infant's food. Never hang an infant in anything on a hook to weigh it. Such weights are usually, from the continual kicking of the infant, quite incorrect. Do not think that the kitchen grocery scale is good enough for the infant. We can afford to have incorrect and approximate grocery weights, but cannot afford to apply these methods to the growing infant, with its unstable equilibrium. The scales should be of a small but solid platform variety, which can be placed on a firm table by the tub where the infant is to be bathed, for use before the bath. Here are the scales which I am in the habit of using. (Fig. 36, platform scales on table, page 131.)

These scales weigh from four or five grammes (one drachm) up to ninety kilogrammes (two hundred pounds). A basket, with a small soft blanket lining it, is placed on the platform of the scale, and the naked infant is weighed in the basket. The scale is balanced, and the infant immediately taken out of the basket without stopping to read the weight, so as not to expose it too long while uncovered. When the infant has been dressed the scale can be read, and the balance-weight minus the weight of the basket and blanket (which can, of course, always be a constant quantity) gives us the exact weight. Weighing with the clothes on I have found a very unsatisfactory procedure.

**BATHING.**—The question of the bath is one which you will frequently be asked about, and is indeed of a good deal of importance in the early months of life. Unless there is some definite contra-indication, I think that an infant should be bathed every morning. The contra-indications are if the skin or nails turn blue, or if the infant seems in any way to show symptoms of weakness or lowered vitality after bathing, such as are represented by cold extremities and nose, or an unusually quickened respiration. In these cases sponging, merely sufficient for cleanliness, is to be substituted for the bath. The bathing should be done with celerity, the tub being placed on the side of the fireplace opposite from the window, and fronting the latter, so as to avoid draughts and insure a good light, care being taken at the same time to protect the infant's eyes from a strong light. I will now describe to you the manner in which I prefer the details of the bath to be carried out. The nurse sits with her face to the light and has the infant on her lap, wrapped up in a warm blanket, with its feet towards the fireplace,



and its head in such a position as regards the window as to avoid having too much light in its eyes.

**TEMPERATURE OF BATH.**—The water should vary in its temperature somewhat with the age of the infant, but should never be so cold as to cause blueness or cold extremities. We must also be careful not to have the water too hot, as this has sometimes proved to be injurious. Each infant, however, must have the temperature of its bath adapted to its own vitality. This table will, in a general way, guide you in determining which temperature at each age you had better begin with.

TABLE 32.

*Temperature of the Bath for Different Ages.*

Age.	Centigrade.	Fahrenheit.
At birth . . . . .	36.6°	98°
During first three or four weeks . . . . .	35°	95°
One to six months . . . . .	34°	93.2°
From six to twelve months . . . . .	32.2°	90°
Twelve to twenty-four months . . . . .	30°	86°
Then gradually reduce in summer to . . . . .	26.6°	80°
In the third or fourth year, if possible, reduce to . . . . .	23.8°	75°

The nurse first washes the face in clear water, keeping the body and limbs wrapped up in a warm blanket. She should gently cleanse the nose, the corners of the eyes, and the external ears. The nose is especially important, for the infant's vitality is easily affected by occluded nares. The face is then wiped with a soft towel. The nurse should then soap, wash off, and dry the scalp. The sponge and water in the other division of the bathing basin are then used for soaping the body and extremities. Especial care should be paid to the folds of the neck, the axillæ, groins, genitals, and anus. The temperature of the water in the basin and bath should be tested from time to time with the bath thermometer until the washing is over. The proper warmth of the water is to be kept by adding when necessary a little hot or cold water from cans within easy reach.

**TUB.**—The tub, which is preferably made of rubber hung on a simple wooden frame and sufficiently high to prevent needless stooping on the part of the nurse, is placed, as I have arranged this room to show you (Fig. 36), on the nurse's left, at a convenient distance from her chair.

**BASIN.**—In front of the nurse is the double washing basin, which, as you see, is merely a china basin divided into two compartments, and fitted to a wicker stand, also sufficiently high to prevent the nurse from stooping as she uses it. To the right of the nurse is the table, with the scales on one end and the toilet basket on the end towards her.

**SOAP.**—The soap should be white castile, or any kind which is free from irritating elements.

**SPONGES.**—There should be two sponges: one goes in one side of the washing basin, and is for the head and face; the other is to be used in the opposite side of the basin, and is for the body and extremities. The body

and limbs having been thoroughly and quickly soaped, the nurse should gently lower the infant into the clear water in the bath, being careful not to frighten it or drop it. This is not an unnecessary warning. I have known infants, even in the hands of ordinarily careful mothers, to be dropped from the bath or scales, with a resulting permanent injury of the spine or hip. After allowing the infant to kick and splash for a few seconds, it is taken back into the nurse's lap and carefully dried with a warm soft towel. Never soap and wash the infant in the bath, but always on the lap.

POWDER.—When the skin is perfectly soft, clear, and in a normal condition, no powder is needed. Where there is any slight irritation, which, at times, is liable to occur when the skin has not been kept sufficiently dry, and especially if there is a decided redness in the folds of the skin, as of the neck, axillæ, or groins, this powder can be applied, for which you can write the following prescription :

		PRESCRIPTION 2.	
<i>Metric.</i>		<i>Gramma.</i>	<i>Apothecary.</i>
R	Pulv. zinci oxidi . . . . .	7   5	R Pulv. zinci oxidi . . . . . ℥ii ;
	Pulv. amyli trit. . . . .	60   0	Pulv. amyli trit. . . . . ℥ii.
	M.		M.

No perfume of any kind should be added to the powder. The infant should be sweet and pure in itself, without accessory odors. In addition to this room arranged to show these various details of nursery routine, I have had this diagrammatic picture of the nursery drawn for you to illustrate what I have just said in regard to ventilation and bathing (Fig. 36, page 131).

You see the simple wooden *ventilator* under the lower sash of the window, and the arrows marking the entrance of the cold-air current. Where this current is too strong it can be tempered by pinning a towel across the opening between the upper and the lower sash. The cold-air current passes from the window at a point near the floor directly across the room to the open fireplace. This should at once suggest to the mother that parts of the room, on account of these currents of air which from doors and windows pass over the floor to the fireplace, should be avoided not only for bathing but also for playing on the floor.

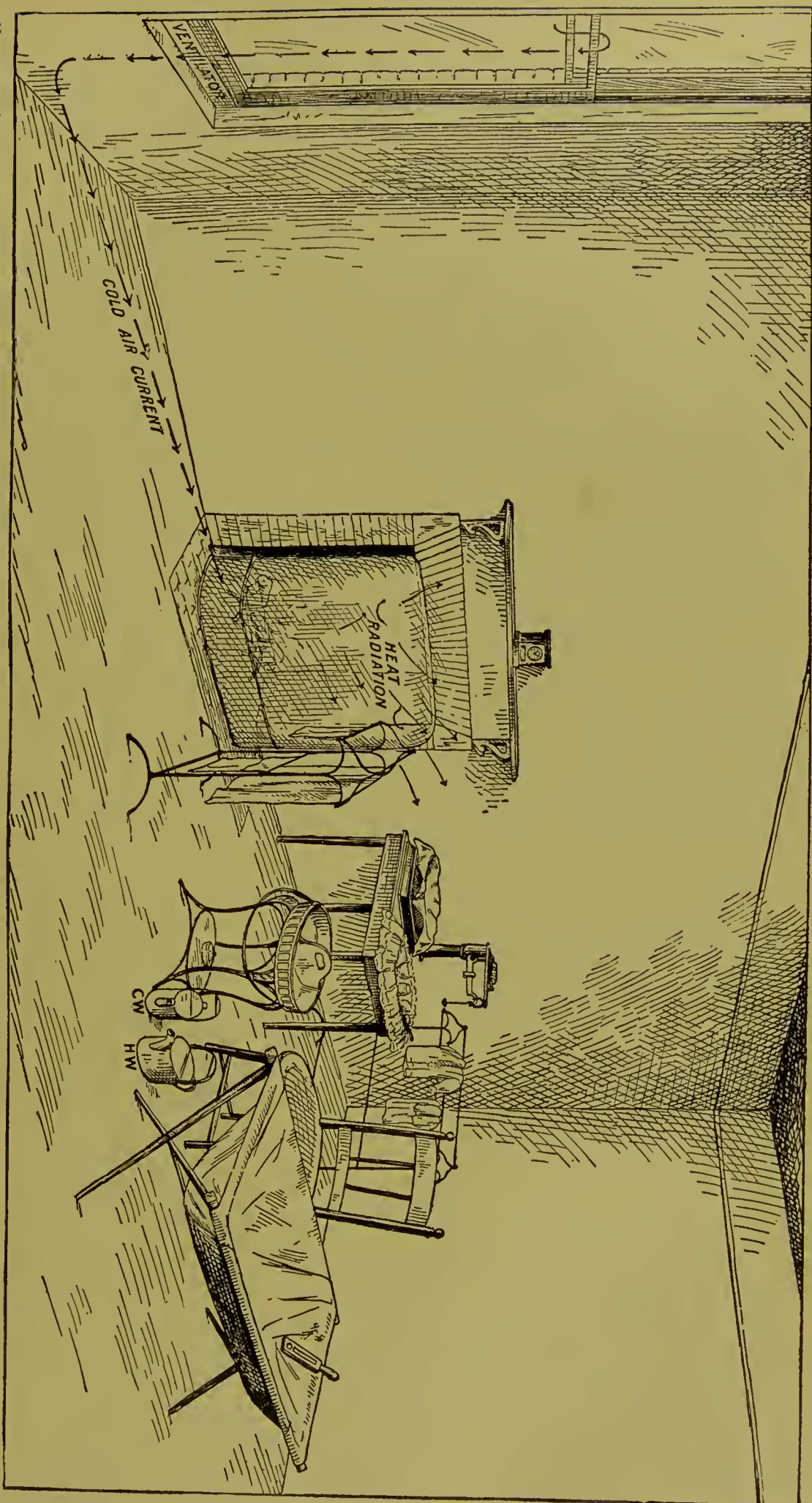
A high *fender* covering the entire opening of the fireplace, and fastened so that the older child in playing cannot pull it down, is an important part of the nursery equipment. It answers two purposes,—one to prevent the sparks from flying out on the child, the other to prevent the child from falling into the fire. Serious accidents have happened from a lack of proper precaution regarding this apparently self-evident necessity. The hot air from the fire radiates in all directions, as is shown by the arrows.

There should be a rack for the towels, which should be kept warm in front of the fire while the infant is being bathed.

The clothes should in like manner be neatly spread out on another rack, ready to be put on as soon as the infant has been dried.



FIG. 36.



Nursery with preparations for bath : ventilator fitted to lower sash of window ; arrows showing cold-air current coming in between the upper part of the upper sash, passing down to within a few inches of the floor and then directly across the room to the open fireplace ; arrows showing heat-radiation coming from the fireplace through the high fender ; table ; scales ; toilet basket ; double basin ; chair ; tub ; thermometer ; cold- and hot-water cans ; towels on rack ; clothes on rack.



The bath thermometer is represented at one end of the tub; it is usually guarded from breaking by a wooden frame, which also allows it to float in the water, and the nurse is thus enabled to see at a glance that the bath-water is remaining at the proper temperature.

CLOCK.—There should be a good clock in every nursery.

There are two conditions of the skin that quite commonly occur in infants, especially in their first year, which, although they are abnormal, usually come from lack of sufficient care in the nurses, and can therefore be spoken of here rather than among the pathological conditions of the skin, which I shall mention later. One is *intertrigo*, the other the *seborrhœa capitis of infants*.

INTERTRIGO.—The former, intertrigo, is merely an exaggerated hyperæmic condition of the skin, usually of an erythematous type and occurring in the folds of the skin. This infant (Case 42, Plate III. A, facing page 112) represents very well this condition in the groins. Napkins soaked in urine and allowed to remain for some time without being changed are a frequent cause of this condition.

Keeping the skin clean and dry and applying the powder will, as a rule, soon cure this intertrigo. At times, however, it becomes much more intense and runs into a pronounced eczema, which is a much more difficult lesion of the skin to deal with and requires special treatment such as I shall describe when showing you cases of eczema in a later lecture (Division IX., Lecture XXI., page 470).

SEBORRHŒA CAPITIS OF INFANTS.—The second condition, which also can well be described in this connection, is represented by

This infant (Case 43, Plate III. B), two months old, which I shall now show you. It has, as you see, a collection of crusts of a brownish-yellow color on the top of its head. These crusts are especially thick over the anterior fontanelle. This condition is called the *seborrhœa capitis of infants*, and you will often be asked whether it is safe to remove it. It should never be allowed to collect, and when present it should be gently and gradually removed by first soaking it with warm sweet oil to loosen the crusts, and then washing it off with soap and warm water. A little simple ointment should be applied to keep the scalp at this point soft and thus prevent the reaccumulation of the crusts. The whole scalp of the infant should be perfectly clean. Seborrhœa capitis is simply a tendency to over-production by the sebaceous glands of their secretion, which, mixed with dirt, produces this condition.

CLOTHING.—It is very important that those who care for the infant should not only clothe it properly but should understand why one method of clothing is better than another. The surface of the infant's body is greater in proportion to its entire weight than is the case in the older and hence larger human being. Greater surface means that there is a greater opportunity for radiation, and hence that the smaller subject will cool off more quickly, other conditions being equal, than the larger one. We therefore see at once that much care should be given to the question of warmth in the infant. Any exposure of the body or limbs in either infants or children is unwise. A very important factor in the problem of growth in the infant

is perfect freedom of motion for its legs and arms and for the respiratory and abdominal muscles. It should also be thoroughly understood that pressure on any portion of the body or limbs must produce evil results, by displacing organs which should be allowed to have entire freedom of position in their respective cavities.

Too little warmth will do harm, by preventing the proper metabolism of the tissues and thus reducing the animal heat. Too great warmth, on the other hand, by causing inequalities in the circulation, will in like manner be detrimental to the child's growth and vigor. Clothes which bind any part of the infant tightly cannot but press out of their natural position whatever happens to be beneath the point of pressure, whether it be the liver, the intestines, or the toes. The clothes, then, must evidently be warm and loose, and we must bear in mind that loose clothes are warmer than tight ones, from the very fact that they do not interfere with the natural activity of the circulation, and that they give freer play to all the muscles which produce the normal warmth arising from exercise. We must remember that the only way in which the infant can obtain the exercise so much needed for proper growth, and which is so easily obtained by the older child in running about, is by continually moving its legs and arms and thus accelerating the muscular action of its thorax and abdomen.

An important item in the proper management of the infant in its nursery is that it should be irritated as little as possible by unnecessary delay in dressing it after its bath. Useless stitches, buttons, and articles of clothing should be dispensed with, and a method adopted which, while combining the necessities of dress which I have just spoken of, will allow the dressing to be finished before it has time to annoy the infant.

**ABDOMINAL BAND.**—There is no necessity for using beyond the first two or three weeks the usual flannel band supposed to be so indispensable by the average nurse. Herniæ, whether umbilical or inguinal, cannot be obviated, and in fact may be produced, by undue abdominal pressure.

This form of abdominal band (Fig. 37 A), which is made of light soft flannel, can be smoothly applied over the dressing of the cord and kept in place with moderate pressure by means of safety-pins.

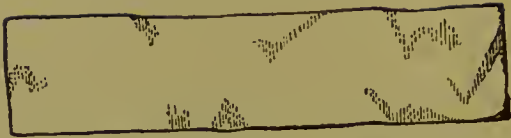
The band can soon be replaced by a somewhat elastic knitted garment (Fig. 37 E, A), half band and half shirt, with shoulder-straps of the same material to hold it in place, and a tab in front to fasten it with a safety-pin to the napkin (Fig. 37 E, B).

This shirt can be made of soft wool or silk, or, as I have recently found, can be knitted in any form or size from half cotton and half silk.

This knit material can also be used for these other undershirts which I have here to show you (Fig. 37 B and Fig. 38 F, page 137). Garments made in this way are the best that I have ever seen. They are warm, soft, and delicate, have no seams, can be washed without shrinking, and retain their elasticity much better than those made from the other materials which I have mentioned.

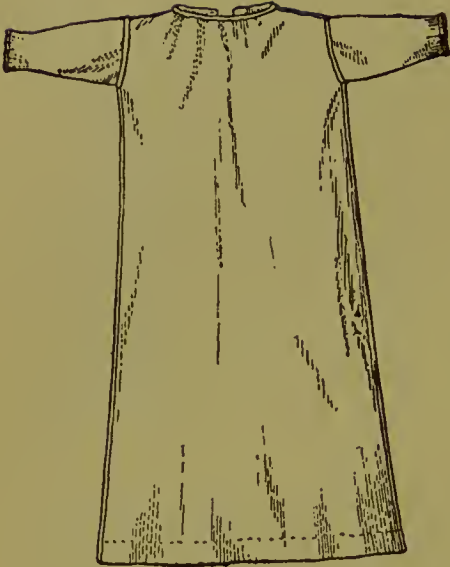
FIG. 37.  
(Long Clothes.)

A



Flannel band for early weeks.

B



Shirt.

C



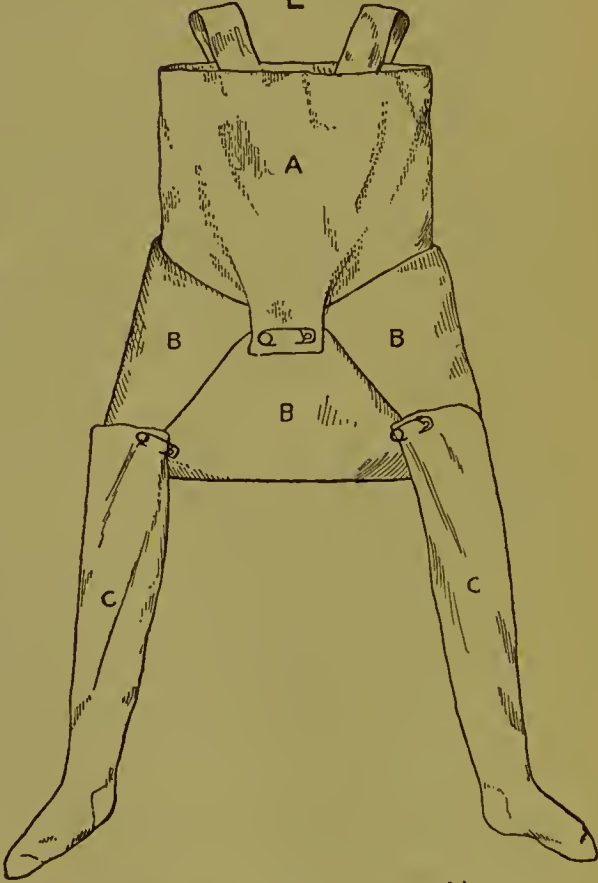
Petticoat.

D



Dress.

E



A, knit band ; B, napkin ; C, stocking.



NAPKINS.—This napkin (Fig. 37 E, B, page 134) is folded and fastened with safety-pins as is customary for keeping it in place. The usual napkin is very cumbersome and heavy, besides being expensive. It can be replaced by rolls of soft absorbent gauze, which absorb the urine from the skin, an important quality in cases where the skin is easily irritated. These napkins can simply be cut from the roll, which is kept in the nursery, and, when removed from the infant after a movement of the bowels, can be burned, thus avoiding the trials resulting from the objections of the nurse or the laundress to washing the napkins. If, however, the mother prefers the regular old-fashioned napkin, small squares of this gauze can be placed in the middle of the napkin, and this will in great measure obviate the more disagreeable part of the napkin-washing, as the square of gauze will hold most of the movement and can at once be burned.

The infant while in long clothes need not have any further covering for its legs, and need have nothing on its feet. There is no particular objection to little knit socks if the mother wishes to use them.

After the nurse has put on the band and the napkin there are left three garments which are usually the clothes needed to complete the infant's outfit of *long clothes*.

These garments are the shirt (Fig. 37 B, page 134), the petticoat (Fig. 37 C), and the dress (Fig. 37 D).

SHIRT (Fig. 37 B).—The shirt is a garment with long sleeves and high neck, cut almost as long as the outside white slip or dress. Unless it is knitted, as I have before described, it is well to have it made of some soft, fine, all-wool material, with the seams finished on the outside to prevent irritation of the skin. It is made to button in the back. A fresh garment of this kind is also sufficient for the infant's dress at night, except during the early weeks of life.

PETTICOAT (Fig. 37 C).—A flannel shirt cut all in one piece, as the shirt is, made of fine flannel with no sleeves and with low neck, represents the petticoat. It should be made large enough to go over the shirt, should be of the same length as the dress, and should also be made to button in the back. The taste of the mother can be gratified by any reasonable degree of embroidery which she may wish to put on this second garment, but the shirt should be perfectly plain.

DRESS (Fig. 37 D).—The outer garment should be made of some soft white material, such as nainsook, should be large enough to go over the shirt and petticoat, should not be starched, and is usually about one yard long from the neck to the bottom of the skirt. It should have high neck and long sleeves, and should button behind.

The advantage of this costume is that it is loose but warm, and that the three pieces which constitute it can be put on together, the infant having to be turned over only once before the clothes are buttoned. The other methods of clothing usually necessitate turning the baby over several times in the process of dressing.

Before the infant has had its bath, these three articles of dress are to be arranged one inside of the other, ready to be slipped on all three at once. This can be done with great celerity, and the dressing process can thus be gone through without the usual accompaniment of irritated cries which are so frequently heard in the nursery, and which are to be deprecated.

When the infant is old enough to have its long clothes changed to short ones, which is at about the time when it learns to creep, the under-garment can be replaced by a knitted or fine all-wool undershirt with high neck and long sleeves (Fig. 38 F, page 137) made short, with an additional white petticoat in winter if desired. The infant should now also have its feet and legs covered with long white wool stockings, which are kept in position by being pinned to the napkin (Fig. 37 E, B, page 134). When the child begins to walk, soft kid shoes should be used with the soles adapted to the natural curves of its feet, as I have explained in a previous lecture (Division II., Lecture IV., page 105), and as I shall presently show you (page 139).

**STOCKINGS.**—A word more in regard to the stockings may not be out of place, and is especially needed in reference to the older child in its third, fourth, and fifth years. It is a mistake to think that if we keep the feet and abdomen warm the legs can be left uncovered with impunity. Short stockings and bare legs, in my opinion, should be abolished, as a prolific source of catarrhal conditions. The argument is a poor one that certain children have been known to grow up well and strong with uncovered legs, or even that our ancestors were in the habit of depriving their children of suitable coverings for their necks and arms as well as legs, while they themselves were warmly clothed from head to foot. Our ancestors did and said many things which, to us, convict them of great ignorance. I have said that the stockings should be white. This is to insure freedom from poisonous dyes, which at times seriously affect the delicate skin of the young child. Colored stockings are a source of great gratification to lazy nurses and to those who wish to lessen the size of their laundry.

There are three garments which are usually put over the shirt and are considered to complete the short clothes. These are the flannel petticoat, the white petticoat, and the dress, and they are to be made large enough to fit one over the other and thus to be put on all at once.

**FLANNEL PETTICOAT** (Fig. 38 G, page 137).—The inner garment next to the shirt has a flannel skirt, a cotton waist, low neck, no sleeves, and is fastened with buttons in the back.

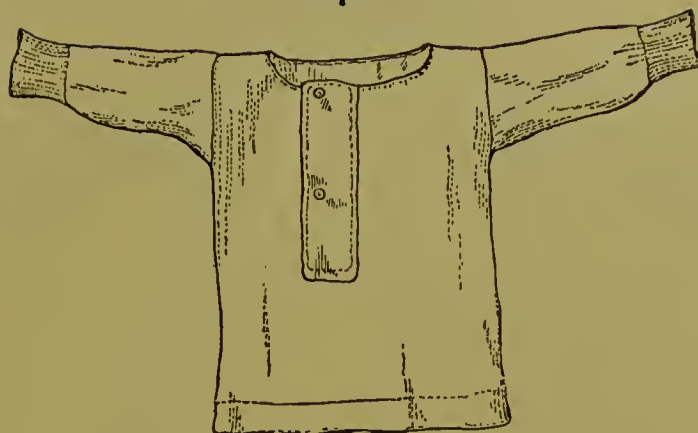
**WHITE PETTICOAT** (Fig. 38 H, page 137).—Next to the flannel petticoat comes a garment with a skirt of some soft white material, with a cotton waist, low neck, no sleeves, and also buttoned in the back.

**DRESS** (Fig. 38 I, page 137).—Finally, over all the other garments comes the dress, which is made with high neck and long sleeves, and is buttoned behind.

**NIGHT-DRESS** (Fig. 38 J, page 138).—A regular night-dress can now be used, made of soft flannel, with high neck and long sleeves, and

FIG. 38.  
(Short Clothes.)

F



Shirt.

G



Flannel petticoat.

H



White petticoat.

I



Dress.



FIG. 38.



Night-dress.

buttoned behind. An extra garment can in cold weather be worn under the night-dress if deemed advisable for the especial child.

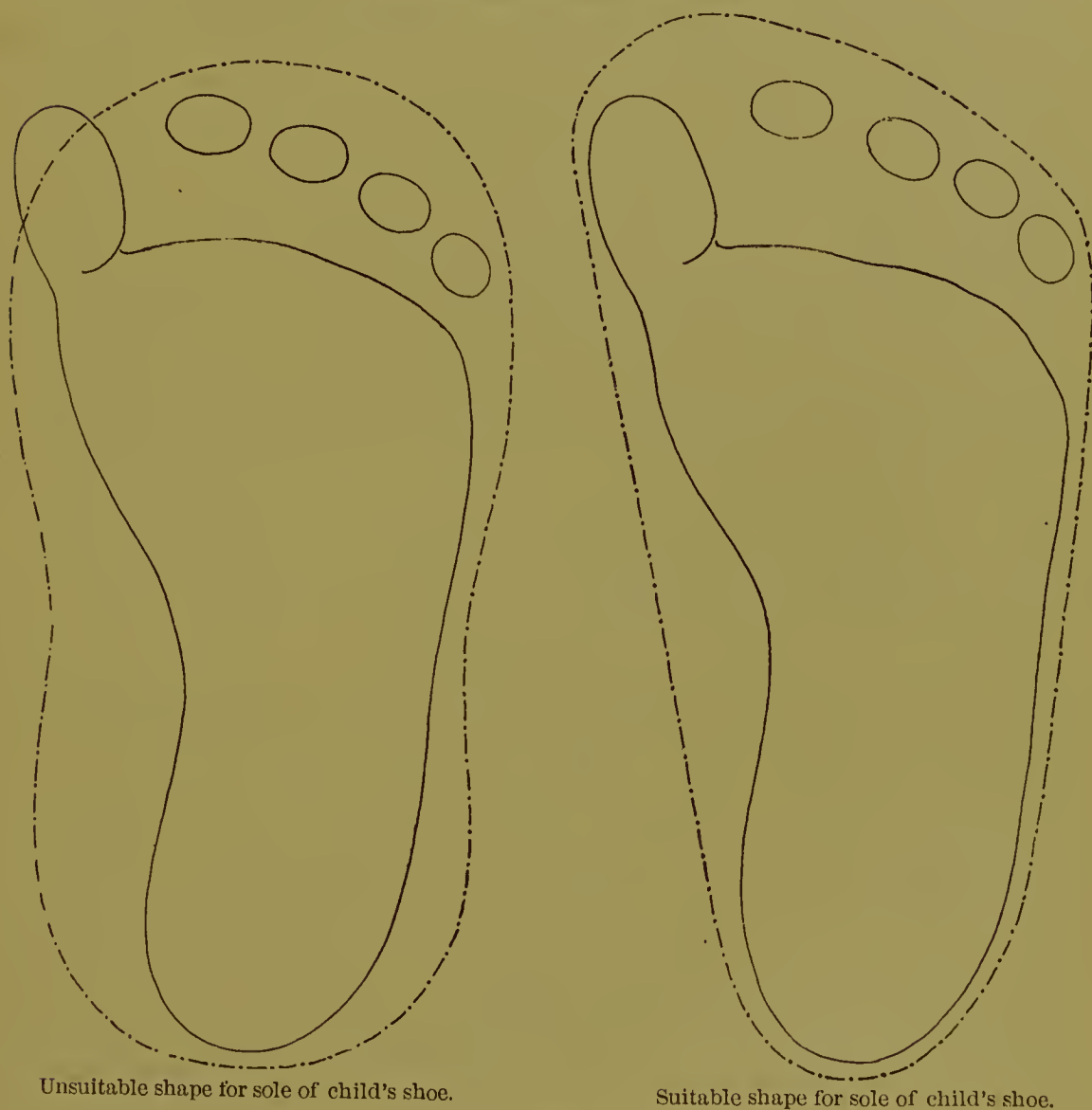
**FEET.**—I have already spoken somewhat at length about the instep, and how important it is to guard it from the usual injudicious treatment which it receives. In young children, although the foot may be well formed, it is very weak, so that the arch is easily broken down. The pad of fat to which I have previously referred (Division I., Lecture II., Fig. 13, page 50) is a physiological protection against such breaking down. Children should not be allowed to walk until some time after they are ready to do so, always allowing, of course, that if they insist on walking they can seldom be restrained from doing so. As they get older, long walks with their parents should, if possible, be forbidden, for it is through these long walks that the evils which I have just endeavored to explain to you are brought about. The child will get exercise enough at its play, and in doing so will not overtax the arch of its foot, or use its feet beyond the degree which nature intended. Children should not be told to turn the toes out too much, as this puts the arch in a position where the muscles give it least support. The average dancing-school master is a fair example of what over-zealous ignorance combined with the respected traditions of the past can do to children's feet.

**SHOES.**—Children's shoes should be rights and lefts, like those of adults, as the present style of straight shoe gives no support to the arch during a

very important period of its growth; this, moreover, also tends to push the great toe towards the median line of the foot, and so to cause enfeebling of the muscles which have so much to do with the proper elasticity of the feet.

We should, therefore, have shoes properly adapted to the child's foot,—shoes that will at once be comfortable and leave the feet free to develop and fulfil all their functions. The children's shoes as we find them in the stores have the two sides of each shoe symmetrical and equidistant from the

FIG. 39.

CASE 44. (Natural size,  $1\frac{1}{2}$  years.)

middle line; the right and left are told only from the arrangement of the buttons, and are frequently worn interchangeably. Now, the foot has no such median line on each side of which the parts are equally disposed; and its two edges are very different, as a glance at the soles of this one-and-a-half-year-old child's feet will show (Case 44, Fig. 39).

We must note especially that the phalanges of the great toe do not naturally point towards the outer border of the foot: such a position, common as it is in the adult, must be considered as an acquired deformity which started, in all probability, with the first pair of leather boots.

I will now show you how contrary to all anatomical rules are the shoes which are usually sold for young children. Dr. Dane, to whom I am indebted for all these valuable suggestions concerning children's feet and shoes, has made a tracing of this child's foot to show how the lines of the sole ought to run, in order to be adapted to the anatomical conditions. The dotted line around the left-hand tracing shows the shape of the shoe that was provided for the child's foot at the shoe-store.

That this matter of forcing the first toe out of its normal position may bring with it very serious consequences is easily shown: as it inclines against the terminal phalanx of the second toe, it often crowds it backward, and finally makes it the distressing "hammer toe," which may even require a surgical operation for its relief. On the inside of the foot, as soon as the axis of the first toe is bent, we begin to find a bulging out of the metatarsophalangeal joint, which in later years, fostered by pair after pair of tight and ill-fitting boots, is capable of giving the most exquisite pain. Still more subtle in its working than this is the trouble that often comes from disabling the great toe from performing its full function. The elasticity of our step depends largely upon our power to press down firmly with the great toe and then raise the weight of the body over it as a support; when this is lost by crippling the toe with ill-shaped boots, the muscles not only of the first digit but of many adjacent groups begin to atrophy. This soon leaves the internal arch of the foot without sufficient support, and the long series of woes incident to "flat-foot" is started upon. Therefore, for one and all of these reasons, let us demand that children's feet shall have at least the chance to develop properly in well-fitting anatomical shoes.

**SLEEP.**—Infants and young children vary much as to the amount of sleep which they need and take during the day. At first they sleep almost continuously, especially if they happen to be somewhat premature. In a few weeks, however, they begin to have regular periods of rest, consisting of several hours' sleep, at first twice in the day, and later once. The more sleep they can be induced to take in the twenty-four hours, the better. As they grow older the amount of sleep which they take grows less, but in the first four or five years of life it is well to try to induce the child to rest quietly on its bed for at least an hour during the day.

**WHEN TO GO OUT OF THE HOUSE.**—If the infant happens to be born in the winter months and the weather is at all severe, it is better to keep it in a well-ventilated nursery, such as I have already described, than to run the risk of its vitality being lowered by exposure to cold. I believe that infants in our Northern climate are exposed to cold far more than they ought to be, and that they need fresh, warm, dry air, rather than the cold and often damp air of our winter months. When they are born in a milder climate, or at a warmer season of the year, they can after the first few weeks be taken out in their carriages often twice a day. When the infant is five or six months old I am in the habit of giving the following directions to the mother as to when she shall send it out. I explain to her that it makes as



much difference whether the air is damp or dry, and what the rate of the wind may happen to be, as does the number of degrees indicated on the thermometer. If the sun is shining, the air dry, and there is no wind, the infant can without harm go out for an hour in the middle of the day even at a temperature of  $-6.6^{\circ}$  to  $-3.8^{\circ}$  C. ( $20^{\circ}$  to  $25^{\circ}$  F.). Where, on the contrary, the air is damp, or the rate of the wind is great, it is better for the infant to remain in its nursery, and, at any rate, not to go out, if the temperature is below  $0^{\circ}$  C. ( $32^{\circ}$  F.). The practice of allowing the infant to sleep in the open air in its carriage in every kind of weather is, I believe, a bad one; but on the days when it is proper for it to go out, such as I have already described, it can without harm sleep in the open air. The nurse should be directed to protect the infant's eyes from the direct rays of the sun, and not to allow a strong wind to blow in its face.

Where the weather has been too severe or damp for the infant to go out in its carriage for some time, it is advisable to have it dressed warmly and wheeled up and down in its nursery with the window open for fifteen or twenty minutes. To avoid too much draught, blankets can be placed over the cracks of the doors and the open fireplace while the infant is breathing the fresh air. The room being far above the ground, the dampness is avoided, and even a considerable velocity of the wind outside the house will in this way be unable to affect the air of the room, and will not make too strong a draught.

Not only should an injudicious administration of cold air be avoided, but extreme care also should be taken in hot weather that the child is not exposed to too great direct heat from the sun, and it should never be kept in a hot atmosphere where currents of fresh air cannot have access.

**NURSERY-MAIDS.**—The idea that the child should be taken care of by an old, experienced nurse is a vicious one. The experience of nurses, as a rule, is that of ignorance rather than of intelligence. Every mother, as she is presumably more intelligent than the nurse whom she employs, and is surely more interested in the welfare of her child, should personally supervise and unhesitatingly investigate all that the nurse does to the child. The nurse's ideas as to what is needed for the child's hygienic surroundings, food, and clothing can well be dispensed with. The mother, learning from the physician what is best for her child, should give her directions to the nurse and see that these directions are strictly carried out. A nurse between the ages of thirty and forty is preferable to one who is younger or older. She should be neat, healthy, strong, cheerful, gentle, and patient. She should be willing to refer small details of the nursery routine to the mother, as well as those which appear of greater importance. The chief attributes of a good child's nurse, in my opinion, are a desire to obey implicitly the orders which she receives from her mistress, and a temperament in harmony with the sensitive nervous organization of her charge.

**MOUTH.**—I shall ask you to join me in entering a protest against the way in which the nurse, and in fact almost every one who comes near the

infant, put their fingers into its mouth on all occasions. It would seem as though the infant's mouth was considered by those who ought to know better as something which was especially made to be felt. Infants are much more likely to have various diseases in their mouths than are adults, and probably one reason for this is that dirt of all kinds is constantly being introduced into them. The fingers should always be thoroughly washed before entering the infant's mouth, and yet unwashed fingers are continually feeling the baby's gums to ascertain if a tooth can be found.

The nurse should be instructed that she is never to kiss the infant on its mouth, or allow any one else to. The germs of disease can well be transmitted in this way. It is partly through ignorance of its doing harm, and partly through timidity on the part of the mother in prohibiting it, that a stop is not at once put to this bad habit of nurses and friends, and it is the physician's duty to warn mothers on this apparently trivial but really important question.

In a later lecture, when speaking of tuberculosis (Case 263, page 603), I shall report to you a particular instance where the child was, in all probability, infected by its nurse.

**SCHOOL.**—I have not a great deal to say about schools. I think, however, that much ignorance of the child's nervous organization is shown, by those who should best know how to care for it, at a period of life when its hygienic surroundings, both mental and physical, are extremely important. No one system is good for all children. I am sure that I have seen the kindergarten system do harm to a number of children, although it seems to suit others. Each child should be gauged for itself, and not be forced into any general system, even if that system has proved to be good for the many. No time is lost, in my opinion, in sending children to school at a somewhat later age than is usually supposed to be necessary. I am continually having to take little children out of school who are fretful and have loss of appetite. Neither parents nor teacher seem to appreciate that the little, actively growing brain is overtaxed by too great stimulation and is protesting against such treatment by these general symptoms. Many a child is being dosed with tonics who merely needs rest from school. The parents should keep the most rigid supervision over their children while at school, and notice from their behavior whether they are mentally tired. This supervision should not be left to the teachers alone, however interested they may be in their little pupils. It seems hardly necessary to state that the school-room should be well ventilated, and that at stated intervals during the school hours the windows should be thrown open and the atmosphere of the room completely changed. This should not, however, be done with the children in the room. Attention should be paid not only to what the children eat at lunch, but to how and where the lunch is eaten. A child really needs nothing but dry bread between its meals, so far as its nutrition and digestion are concerned.

**DEFECTS OF POSTURE.**—How can we better appreciate the importance of following nature as closely as possible in its methods of developing young human beings so as to perfect their various functions to the



fullest extent, than by examining carefully this group of malformed children which I have brought here to show you? (Cases 45, 46, 47, 48, and 49.)

BACK.—The extreme flexibility and slow development of the spine clearly point out to us that nature intends to leave its function in abeyance and bring it into use slowly. If the young infant is allowed to sit or stand at too early an age, the superincumbent weight of the large head tends at once to exaggerate the physiological curves of the spine to a point where they may become pathological. As I have already told you in my lecture on Development, during the first year of life the strength of the spinal column is slowly increasing. Not before the seventh or eighth month has it acquired sufficient rigidity to warrant the child's being allowed to sit up. Artificial methods, therefore, of making the young infant assume a sitting posture at a period of development when the spine should be comparatively straight should be deprecated. I have met with numerous instances where both parents and nurses were anxious to have the infants, at a very early age, sit for quite a long time strapped in small chairs. In like manner the same infants were encouraged to stand and walk long before the apparatus for locomotion was ready for use. We may ask, how many of these individuals developed a spinal curvature in later childhood? Possibly the risk in a perfectly healthy child may be small. We often, however, in early infancy, cannot determine which individual may become rhachitic, and where rhachitis is present the tendency to abnormal curvature is well known.

We should, then, in our advice as to the proper physical management of the early years of life, be guided by our knowledge of the normal average development. Free play for the infant's legs, when lying on its back in bed, should be a point to be noticed and considered, since we know that pressing down the legs causes strain and curvature in the lower spine. Knowing the great lateral flexibility of the infant's spine, we should advise the nurse not to hold the infant continually on one side. Symmetry of development and free opportunity for natural movement should be our aim in the management of the infant from the very earliest period of its existence. Our knowledge of the great flexibility of the growing spine provides us at once with a most valuable means for treating lateral curvature in childhood, and we are continually seeing the benefit of encouraging the promotion of elasticity by moderate pressure and bending. A case which is now under observation in my service at the Infants' Hospital beautifully illustrates the truth of what has just been said.

A feeble, rhachitic child (Case 45), nineteen months old, was presented for treatment with a marked lateral curvature in the dorsal region, the convexity being towards the right, combined with decided rotation, following the type of the worst adult cases.

The condition seemed to be purely the result of habit, the patient having been made, when very young, to sit up beyond the limit of endurance of the still undeveloped bones and ligaments. The treatment instituted by Dr. R. W. Lovett, who took charge of the case, was based entirely on the elasticity of the spine, and consisted simply of manipulation and recumbency, resulting in a very great degree of improvement both as to the curvature and the twisting.



Dr. Lovett also tells me that in the surgical out-patient clinic at the Children's Hospital the improper treatment of the young subject's spine, as in infants, for instance, where they are carried altogether on one side, is well recognized as an important factor in the etiology of rotary lateral curvature. I have seen in this clinic a number of examples of this class, and have been much impressed with the important relation which anatomical knowledge bears to clinical prophylaxis, diagnosis, and treatment.

If you will bear in mind what I told you in speaking of the ossification of the different parts of the spinal column, you will readily understand that so long as an infant can be made happy in the prone position, whether in its nursery or in its carriage, it will be better for it to be kept in this position, always protecting the eyes when out in the open air from the strong light, and the face from the wind. During the first year when it begins to sit up in its carriage its back should be carefully supported by a pillow.

CASE 46.

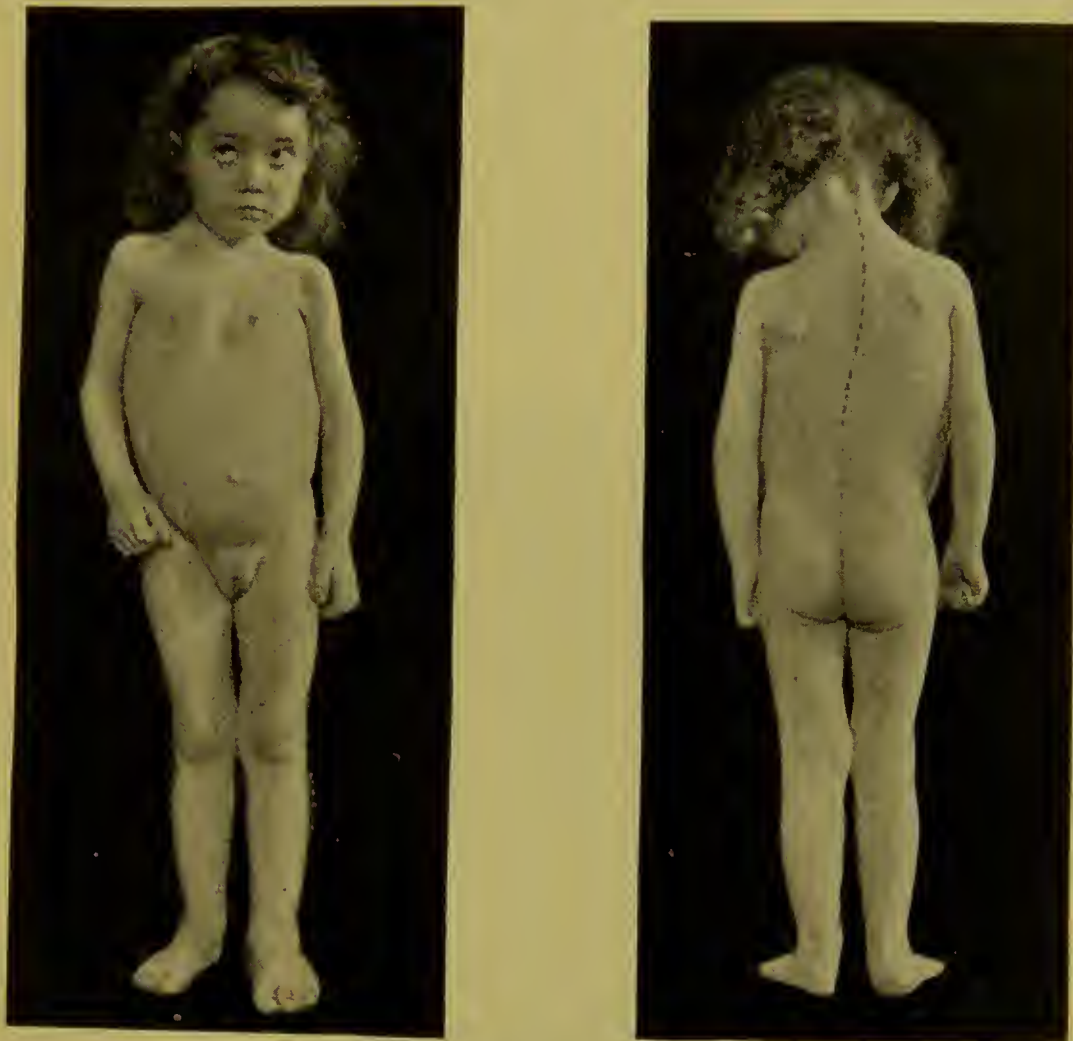


Posterior spinal curvature from sitting too soon.

I have here to show you an infant (Case 46) who is a fitting example of the harm which can be done by encouraging children to sit up before their spinal columns are sufficiently strong. This infant, six months old, has been made to sit in a chair for hours at a time, strapped in a position which allowed it to use its arms, but such as to render it impossible to fall back and rest itself. You see the exaggerated curve of its back, which corresponds to that which would be seen normally at birth. Such a curve I have already shown you in Diagram II., Curve 1. If this infant had not been made to sit until it had developed sufficiently to acquire the physiological curve (Diagram II., Curve 2), it would not at this age show any spinal curvature. It has, however, through improper treatment reacquired the posterior curvature (Diagram II., Curve 1) of the early hours of life.

As the child grows older, weak undeveloped muscles have a tendency to allow lateral and posterior curvatures to be produced. Habit, of course, has much to do with these faulty positions of later childhood.

## CASE 47.



Lateral curvature of the spine. Child four and one-half years old.

This little girl (Case 47), aged four and one-half years, shows a lateral curvature, not from disease of the spine, but one which is usually explained as a result of superincumbent weight coming upon muscles which are unable to support it properly.

You will notice, on looking at her from behind, the curve which the line of the spinal column takes to the right in the dorsal region, so different from the straight line of the normally developed boy which I showed you in my lecture on Normal Development (Division II., Lecture IV., page 124, Case 38). On looking at this same child in front, you will notice how the right shoulder is higher than the left and how the whole thorax is in a distorted position. These deformities are always more readily recognized by looking at the child in front and preferably across the room, as the outline of the chest and hips is much more clearly defined on the anterior aspect of the body than on the posterior. Posteriorly you will in cases even of the slightest lateral curvature at once notice the difference in the level of the tips of the scapulæ. This child stoops, and has what is commonly called round shoulders.

This should teach you that in any case of round shoulders lateral curvature should be thought of and carefully eliminated.

Faulty attitudes in sitting and standing play a great rôle in producing these curvatures. We must, however, acknowledge that such spinal curvatures have been differently explained on the ground that they are the result of a lack of development of all the tissues upon one side of the spine. Other explanations have also been given ; but in certain individual cases it is impossible to formulate any reasonable cause for the curvature.

LEGS.—At birth the infant's legs are curved rather than straight, as I have already described to you (Lecture IV., page 118), when I showed you the infant skeletons at birth and at nineteen months. The natural tendency of the growth of the legs is to become straight, but if the child is encouraged to stand and walk too soon, especially if the bones have not been properly nourished, the weight of the head and trunk becomes too great to be supported by the legs, which curve outward in the form of an ellipse, a condition which is called "*bow-legs*."

CASE 48.



Bow-legs. Child three and one-half years old.

This little boy (Case 48), three and one-half years old, has, as I learn, been encouraged by his parents to stand and walk before he was a year old.

His nourishment has also been rather imperfect, but he is not rhachitic. You see as the result of this combination of circumstances a decided bowing of both legs. He is being treated in my ward for facial eczema, which accounts for his rather startling head-gear. I shall describe him as a case of eczema in a later lecture.



The deformity called "knock-knee," in which the leg at the knee bends in rather than bows out, may occur from simple weakness, but is so rare except when rhachitis is present that it is better to speak of it in connection with that disease.

Finally, I should like you to examine carefully this girl's back (Case 49).

She is fourteen years old, and presents, as you see, a typical case of bow-legs and of lateral curvature.

These conditions are not the representatives of disease of the bone existing now, but are the result of improper nutrition causing the bones to become softened (rhachitic) and easily bent. They are also the outcome of lack of care to correct, by proper gymnastic exercises, weak muscles and bad positions of the trunk. When we consider that such conditions as we see so marked in this girl could have been obviated by proper treatment at an earlier period of childhood, when they were beginning, we can readily understand the importance of careful medical supervision in preventing the acquisition of various deformities.

**VACCINATION.**—It is now pretty well accepted throughout the world that the introduction of the vaccine virus into the circulation protects the individual from variola. The physician in general practice, however, is so often questioned as to the advantages in contrast with the dangers of vaccination, that it is particularly advisable in regard to infants and children to know a few facts, especially concerning primary inoculations. According to the careful investigations of McCollom on the history of variola and vaccination, compulsory vaccination was suspended in Zurich, Switzerland, in obedience to popular clamor, in 1883. The deaths from variola, out of one thousand deaths from all causes, for the previous two years and that year had been,—in 1881, 7; in 1882, 0; and in 1883, 8. After compulsory vaccination had been done away with, the deaths rose in 1884 to 11.45, in 1885 to 52, and in the first eight months of 1886 to 85 per 1000.

In this connection it is of interest to note that during the epidemic of variola in Prague in 1888, 76.57 per cent. of the unvaccinated died, while only 10.58 per cent. of the vaccinated succumbed to the disease.

In Boston from 1721 to 1792, a period of seventy-one years, there were three very severe and fatal epidemics of variola, or one in about every twenty-three years. From 1792 to 1892, a period of one hundred years, there had been only one severe epidemic of this disease, and even this could not be compared in severity with those in the last century. The protective power of vaccination is the only possible explanation of this comparative immu-

CASE 49.



Spinal curvature and bow-legs. Girl aged fourteen years. Rhachitis and lack of care in earlier childhood.

nity from variola during the last hundred years. In the past ten years the percentage of deaths among the unvaccinated at the Boston Small-Pox Hospital has been 75, while that of the vaccinated has been only 3 per cent. In the past twelve years no person who has been successfully vaccinated within five years has died of variola, and those who have been attacked by variola have had the disease in a very mild form.

Dr. Barry, in his report of an epidemic of variola at Sheffield, England, during 1887 and 1888, gives a very clear idea of the relative frequency of deaths occurring in the vaccinated and in the unvaccinated. I have arranged a table (Table 32 *a*) which illustrates his results very well, and shows the percentages of those who, living in houses invaded by variola, were attacked by the disease, and also how many of these died. It also gives the percentages for all ages, for under ten years and for over ten years.

TABLE 32 *a*.  
*Individuals living in Houses invaded by Variola.*

		(1) All Ages.	(2) Over 10 Years.	(3) Under 10 Years.
Vaccinated.	{ Attacked . .	23.0 per cent.	28.1 per cent.	7.8 per cent.
	{ Died . . . .	1.1 “	1.4 “	0.1 “
Unvaccinated.	{ Attacked . .	75.0 “	68.0 “	89.9 “
	{ Died . . . .	37.2 “	37.1 “	38.1 “

The low percentage of children as shown in column (3) is very striking in comparison with column (2), which represents older individuals and enunciates the importance of revaccination. A glance at the table at once impresses upon us the significance of the difference in the number of deaths between the vaccinated and the unvaccinated. We can hardly imagine any other explanation for this great difference in the mortality rate than the supposition that the vaccine virus is highly protective against variola. Still more striking are the actual figures recorded as representing very large numbers of cases of variola. These figures show that among the vaccinated, nineteen individuals out of twenty recovered, while of the unvaccinated, fifty individuals out of one hundred died. It is not held by the advocates of vaccination that one vaccination will protect for a lifetime. On the contrary, revaccination is just as important as the primary operation. One attack of variola does not always protect an individual from a second invasion, and more should not be expected from the operation of vaccination.

Dr. Josef Körösi, Director of the Buda-Pesth Statistical Bureau, has lately published the statistics of 112,000 observations made with reference to the deleterious after-effects of vaccination. As a result of these observations, the author concludes that, even if any slight increase of mortality can be charged to vaccination in certain specified diseases, there should be placed to its credit a saving of life at least three hundred times as great. Körösi stands at the head of living statistical authorities upon vaccination; hence his conclusions are entitled to great respect. He attaches to vaccination a greater preventive power than to any other known means or appliance in the whole field of medicine.



Variola has been communicated to the cow by direct implantation of the virus. The efforts to accomplish this were numerous and at first unsatisfactory. The first successful inoculation of this nature was at Berlin, in 1801. Since then many observations have been made in this direction, and the conclusions of those who have carefully studied the subject and are therefore qualified to judge are that :

1. Variola is inoculable on the bovine species when the method of operation is good and when the virus is taken at the proper time.

2. Inoculation of the calf with variola forms a valuable source, in a new direction, for obtaining animal vaccine. This is of great practical value not only for the vaccine institutions of Europe, but also for those of warmer climates, where variola is frequently endemic and where vaccine rapidly deteriorates.

3. Variola inoculated on the calf is transformed after several transmissions into vaccine by its passage through this animal. Dr. Fischer, Director of the Vaccine Institute at Karlsruhe, in Germany, performed at about the time when Körösi was investigating this subject a series of similar experiments, and he arrived at practically the same conclusions. These experiments, according to McCollom, refute the argument of ignorant theorists, that the vaccine disease cannot protect against variola because there is no connection between these two diseases. Finally, I am authorized by Dr. John H. McCollom, the city physician of Boston, to state that no death from variola has occurred during the last ten years here in Boston of a child who had been vaccinated before it was five years old. With these facts before us, I shall not discuss further the merits and demerits of vaccination, but shall take it for granted that it is well to vaccinate the young infant. The time at which this should be done is, I think, of considerable importance. The infant should be vaccinated early, before it begins to be exposed to the danger of contagion from sources outside of its home. We must, however, remember how low is its vitality at birth, and how readily this vitality is affected by what would be considered trifling conditions for the older child or for the adult. A time should be chosen when the infant is not subject to the other disturbing conditions which naturally arise in the first two years of life, such as weaning and the irritation of the dental periods. If it is found necessary to vaccinate the infant after the sixth or seventh month, or before the twentieth, it should be done in an interdental rather than in a dental period, and not at the time when its food is being changed, or when it is suffering from either slight catarrhal conditions or some definite disease. I prefer to vaccinate the infant when it is four or five months old,—that is, just before the period when the first tooth appears. At this age it has usually become accustomed to its food, its digestion is in equilibrium, and its vitality is much above what it was in the early weeks of its life. By the fifth month also it will usually have developed the outward symptoms of syphilis if it has inherited that disease from its parents. You will thus not be so likely to be blamed for having inoculated with something besides the

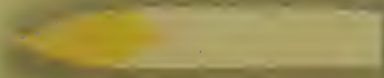


vaccine virus, which might happen if after vaccinating in the early weeks of life a syphilitic efflorescence should appear. The vaccine virus can be introduced into any part of the body through the skin, and according to the fancy of the physician or parents. Girl infants can be vaccinated just below the knee on the outer side of the leg, so as to avoid having a scar on the arm, to which women usually object. I am accustomed to vaccinate boys on the outer side of the upper arm. Whether the vaccination is performed upon the leg or the arm, we should first inquire if the person who is to take care of the infant is right-handed or left-handed. If the nurse, for instance, is right-handed, she will naturally hold the infant on her left arm, and in this case, the infant's right arm being towards the nurse, it is better for the vaccination to be on the left arm. The process should be reversed where the nurse is left-handed, and in this case, for the same reason, it is better to vaccinate on the right arm or leg. The form of virus which I have been accustomed to use, and which I consider the best, is taken from cows rather than from human beings. It should be very carefully prepared by those who have made a scientific study of the subject, and, if possible, on farms which are under State supervision.

I shall now show you the details of vaccination such as I have found in my practice to be the best. It has been pretty well proved by careful observation of large numbers of primary vaccinations that those who in later life contract variola have the disease in a less severe form where in their primary vaccinations they have been inoculated in three places at once rather than in two, and in two places at once rather than in one. The general constitutional disturbance also does not appear to be greater where the inoculation has been in two or three places rather than in one. The evidence therefore seems to be in favor of inoculating in two or three places in primary vaccinations. A very small surface is amply sufficient for the proper introduction of the virus. This pointed ivory quill (Plate IV.) is charged, as you see, with virus, and can be used directly for removing the epithelium, for exposing the smaller blood-vessels, and for introducing the virus. I prefer not to use any more instruments than possible, in order to avoid the possible introduction of some foreign substance which might interfere with the natural course of the vaccine virus and cause unnecessary inflammation.

I will now vaccinate before you this infant (Case 50), a girl, four and one-half months old, and I have chosen as the place for the introduction of the virus this point just below the knee on the left leg. I first wash my hands very thoroughly. I then wet the end of a freshly-boiled clean towel in water that has just been boiled. The skin is then thoroughly rubbed with the hot water, and not dried. This procedure accomplishes two purposes. The first is to remove all dirt or extraneous matter from the spot where we are about to expose the blood-vessels, and thus lessen the danger of septic absorption. The second is to remove the external layer of the epithelium, which has been softened by the hot water, and thus render the subsequent scratching less painful and shorter in its duration. I now make a series of short scratches about one-half centimetre (about one-fourth inch) long, four or five in number, and in two sets, one crossing the other, until

PLATE IV



Vaccine Quill



Vaccination Scratch



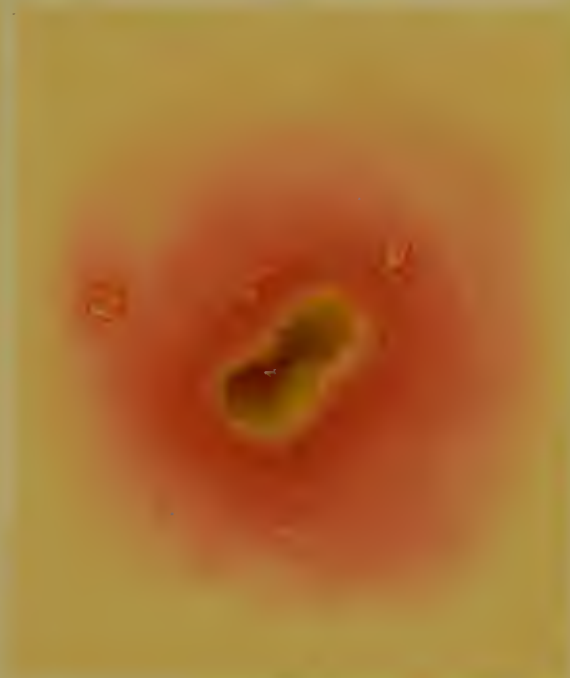
At 5<sup>th</sup> Day



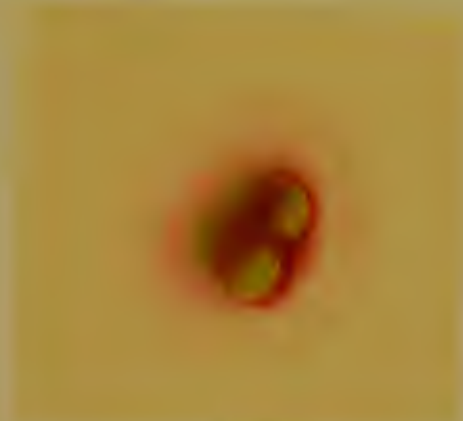
At 8<sup>th</sup> Day



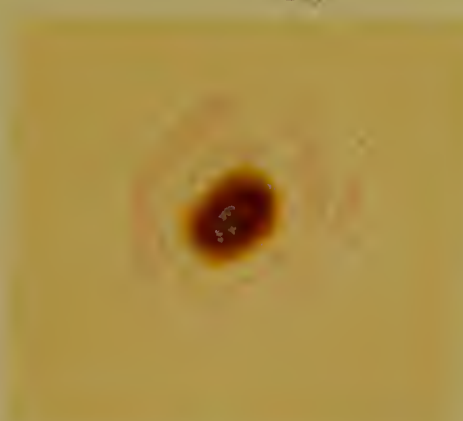
At 10<sup>th</sup> Day



At 12<sup>th</sup> Day



At 15<sup>th</sup> Day



At 19<sup>th</sup> Day



Scar at 1 year



Scar at 21 years





the epithelium is sufficiently removed to show that the blood-vessels are exposed, but not to a degree that bleeding should take place, for in the latter case the virus may be prevented from gaining an introduction to the general circulation. (Plate IV.) The point of the quill should now be dipped into water which has been freshly boiled (sterilized). The flat part of the quill which is charged with the virus is then thoroughly rubbed into the wound. The skin should be protected for four or five minutes from contact with anything; after this the infant can be bathed or go out as usual. In some cases I have waited until the scratch has dried, and then have covered it with a small piece of aseptic cotton which I sealed at the edges with collodion. After three or four days this cotton can be removed, and, unless the subsequent lesion is broken, this measure is an additional safeguard against infection from extraneous matter in the first few days.

Having now shown you the details of the vaccination of this infant, I will also show you a number of cases at different periods of the evolution of the vaccine virus. (Plate IV. shows the different stages as they occurred in one carefully observed case seen by the artist and myself every day.)

This infant (Case 51) was vaccinated *five days* ago. Nothing especial was noticed until yesterday, when a little red papule appeared over the side of the vaccination, and to-day you see at the end of the vaccination scratch a round clear vesicle, while at the other end there happens to be left a little brown crust. (Plate IV.)

This next child (Case 52) was vaccinated *eight days* ago. You see an irregular-shaped lesion about  $\frac{1}{2}$  cm. ( $\frac{1}{4}$  inch) long, and 1 cm. ( $\frac{1}{2}$  inch) wide, somewhat depressed in the middle, and with a clear vesicular border. (Plate IV.)

Here is a case (Case 53) which was vaccinated *ten days* ago. You see that the lesion of the last case (Case 52) has now increased in length to 2 cm. ( $\frac{7}{8}$  inch) long, and to a little over 1 cm. ( $\frac{1}{2}$  inch) wide, but we now have an erythematous condition of the skin forming an areola with a diameter of about 2 cm. ( $\frac{7}{8}$  inch), in the middle of which is the lesion just described. This areola is a light shade of red, and on its outer border are, as you see, irregularly distributed little light red maculæ. (Plate IV.)

This next child (Case 54) was vaccinated *twelve days* ago, and you see very nearly the same appearances as have occurred in the last case, except that the areola is very much more intense in its red color, and has grown to the size of a circle 3 cm. ( $1\frac{1}{4}$  inches) in diameter. Some of the little maculæ have become vesicles. (Plate IV.)

This child (Case 55) was vaccinated *sixteen days* ago, and in place of the vesicular lesion with its depressed centre you see that a crust has formed with a narrow line of redness around it, and on the outer border of this areola the redness is gradually becoming fainter and shading off into the normal skin. (Plate IV.)

Finally, here is a child that was vaccinated *nineteen days* ago (Case 56). The crust is smaller than in the one which I have just shown you at sixteen days, the redness has disappeared, and where the areola was most pronounced there is slight desquamation. (Plate IV.)

This child and its nurse (Cases 57 and 58) present one of the usual appearances of the vaccination scar at *one year* and *twenty-one years*. (Plate IV.)

Of course every case of vaccination does not present exactly the same appearances. The lesions may differ in shape and size, and one individual may be affected more intensely by the virus than another; one may have accompanying severe constitutional symptoms and another have none. The chain of lymphatics may be affected as far as the axilla or the groin.

As a rule, the following description represents pretty well the usual course of the disease. After the vaccination, the skin shows nothing new until the third, fourth, or even fifth day, when a small red point appears. This soon becomes a papule; by the next day a vesicle is developed; about

the sixth day this vesicle usually becomes umbilicated, and is surrounded by a faint red zone. By the eighth day the vesicle is fully developed, and by the ninth day the red zone increases rapidly and the vesicle soon becomes a pustule. By the eleventh or twelfth day a crust is formed, and this crust falls from about the fourteenth to the twenty-first day, in some cases an ulcer being left which heals by another crust being formed, in others the skin remaining intact. From the eighth to the twelfth day there may be a slight amount of fever and coated tongue, with some loss of appetite, and the glands of the axilla or groin may become enlarged and tender. The scar, though perhaps not typical, can usually be recognized by its small depressions (pits) and its location.

In a certain number of cases, instead of this regular progression of the vaccine disease with its characteristic development in a single lesion of the skin, the virus appears to give rise to the original disease cow-pox (vaccinia). Vaccinia is characterized by the appearance of papules, vesicles, and pustules of different sizes in different parts of the body and limbs as well as on the face, and running a definite course. I happen to have a case of this kind to show you (Case 59).

This little girl, two years old, was vaccinated ten days ago. You see the characteristic lesion of vaccination on the arm. You will notice, however, on the side of the nose, on the forehead, behind one of the ears, and on the chest, a number of papules, umbilicated vesicles, and a few pustules. These lesions evidently represent something more than the usual course of a vaccination. It is, in fact, a case of vaccinia (cow-pox). The constitutional symptoms are not pronounced in this case, and there is no doubt that the child will make a rapid recovery.

Vaccinia is in my experience a rare disease; its lesions when following vaccination appear at about the fifth day after the inoculation. At the end of four days, however, minute vesicles can be seen with a magnifying glass.

In some cases, instead of the healing of the scratch in a few days, or the formation of the vesicle of a successful vaccination, irregular excrescences of a fungus-like character may appear. These in all probability have no connection with the true vaccine virus, and are not protective. In addition to the rather rare cases of vaccinia to which I have just alluded, various efflorescences at times appear on the skin, not only in the neighborhood of the vaccination lesion, but also in other parts of the body. They may be present on the fourth or fifth day, or even later, in the second week, and are probably caused by some reflex connection with the vaccination lesion. They vary considerably in form, but are usually represented by a multiple or papular erythema or an urticaria. It should be remembered, where an unvaccinated child has been exposed to variola, that if you vaccinate it within forty-eight hours it will probably be protected, and if within five or six days the variola poison will be so modified as to produce only a mild form of the disease. Following the advice of Dr. McCollom, if such a case were presented to me I should vaccinate the child in two places. I should then wait for forty-eight hours and repeat the vaccination in a third place.



# DIVISION IV.

## FEEDING.

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### LECTURE VI.

#### THE GENERAL PRINCIPLES UNDERLYING ALL METHODS OF INFANT FEEDING.

JUST as the highest aim of medical art should be directed to the province of preventive medicine, so the highest and most practical branch of preventive medicine should consist of the study of the best means for starting young human beings in life. They should be preserved from the perils which surround the early hours of their existence, and be given strength and vigor to resist the attacks which must inevitably be made on their vitality, and which are greater and more dangerous in inverse proportion to their age. With these objects in view, the preventive medicine of early life becomes pre-eminently the intelligent management of the nutriment which enables young human beings to breathe and grow and live. In fact, it is a proper or an improper nutriment which makes or mars the perfection of the coming generations. The feeding of infants is, then, the subject of all others which should interest and incite to research all who are working in the domain of pediatrics. The subject is a great one, and is worthy of the attention of the greatest minds of the age. The responsibility of discussing so serious a question is a grave one. It should be taken up carefully. It should be dealt with broadly. We must acknowledge for the present that in the status of feeding, as it has existed up to the last few years, the average human breast-fed infant was more likely to live, other conditions being the same, than the infant which was fed by any other method. But we must remember that the latest investigations of this subject show very clearly that it is not human milk as a whole which is pre-eminently good, but that it is a varied combination of the different elements of the milk which makes it the best food during the first year of life. It is our province to study and make use of these elements of the food, which were once somewhat mysterious, but which are now rapidly becoming known through the work of patient and careful investigators.



In reviewing the immense amount of literature which has accumulated on the subject of feeding, we find that the superiority of human milk to all other kinds of infant food in the early months of life is acknowledged so generally that it has become an axiom. On the other hand, the opinions expressed regarding artificial feeding in the past are so diverse and so opposed to one another that it is evident that much which has in former years been taught must be unlearned, or rather admitted to be untrue, before we can expect to make any decided progress in this most difficult subject.

In our endeavor to copy nature we may hope that, as our knowledge increases, more and more light will be thrown upon those points which are now obscured by ignorance. It is, indeed, of the first importance that we should recognize our ignorance, and, watching every advance which science is making in this subject, be ready to sweep aside preconceived ideas which do not rest upon established facts, and thus by wise iconoclasm build our knowledge on a surer basis.

The great number of artificial foods used by physicians according to the fashion of the day only proves that artificial feeding has never arrived at that state of perfection where it could compete with human breast feeding. The difficulty in approaching the study of the subject has been that physicians as a class have regarded it too purely from a clinical stand-point. We know, for instance, how easily we may be misled by the apparently good effects of a medicament where perhaps on further investigation, or in the light of some new discovery, we learn that the improvement in the case was due not to the drug, but rather to circumstances entirely apart from it. The same rule applies equally well to the case of many foods and methods of feeding. To state concisely what I have already referred to, we should, in studying the form of nutriment which shall be suitable for an especial period of life, manifestly be guided by what nature has taught us throughout many ages. The researches of science at present, especially in the subject of infant feeding, are wisely directed towards learning to read the truths which nature presents to us. Great progress has been made in reading these truths. What we are also endeavoring to do is to copy them, and in regard to human milk a great advance has been made in our knowledge as to what we are to copy from it.

The feeding problem is one which is hedged about with many difficulties on account of the great diversity of individual circumstances and idiosyncrasies. Certain infants thrive on peculiar mixtures which are not adapted to infants as a class. Many will not thrive on that food which nature has provided for them, and the well-being of an infant will depend much upon the circumstances by which it is surrounded, such as affluence or poverty, country or city life. The constituents of the nutriment which nature has provided for the offspring of all mammals in the early period of their existence is essentially animal and never vegetable. Human beings in the first twelve months of life are carnivora. It is therefore evident that an animal food, entirely and freshly derived from animal and not vegetable

sources, has been proved to be the nutriment on which the greatest number of human beings live and the least number die.

**MAMMARY GLAND.**—In regard to the early months of life, a knowledge of the changes which take place in the mammary gland from many causes is of vital importance and must be kept in view. The methods of modifying the milk in the mammary gland, however limited in their scope, should be carefully investigated and adapted to the individual infant according to its age and size and general physical condition. The mammary gland, in its perfect state, uninfluenced by disease or nervous disturbance, or by the improper living of its owner, is a beautifully adapted piece of mechanism constructed for the elaboration and secretion of an animal food. When in equilibrium it represents the highest type of a living machine adapted for a special purpose,—mechanically, physiologically, and economically. When from any cause this sensitive machinery is thrown out of equilibrium, its product is at once changed, sometimes slightly, but again to such an extent that the most disastrous consequences may follow when it is taken by the young consumer. The breasts of all mammals are elaborators and producers. They are not storehouses for preserving sustenance until it is needed. They are delicately constructed mills, turning out, when demand is made for it, a product which has been directly formed within their walls from material which has been brought through their portals from various parts of the economy. The breast is a compound racemose gland, lined with glandular epithelium, which forms sugar, fat, and proteids, and these are mixed with water and salts from the blood. The epithelial cells are so finely organized, and so sensitive with their minute nerve connections, that changes of atmosphere, changes in food, the emotions, fatigue, sickness, the catamenia, pregnancy, and many other influences, throw their mechanism out of equilibrium most readily, and change essentially the proportions of their finished product. Then again this delicate mechanism adapts itself to the quantity of its product, elaborating a smaller or a greater supply, according to the demand actually made upon it by the consumer. The same breast will either supply the proper amount of milk demanded for the requirements of the average age or a greater amount for the same age in case of a greater gastric capacity. Again, this machinery is regulated as to the time which it takes to produce the average food required for the different ages, a shorter interval of feeding being needed for the younger infant and a longer one for the older. This fact is made evident by the decided qualitative changes which result when the gland is called upon to produce its product at improper intervals. Thus, a prolonged interval lessens the solid constituents in their proportion to the water, while a shortened interval, by exciting the epithelial cells to frequent work, over-stimulates them, with the result of increasing the solids in their proportion to the water. In fact, too long intervals produce a product too dilute, while too short intervals produce a product too concentrated. The analyses of large numbers of specimens of human milk at different periods of lactation show us that not



only do the constituents vary from month to month, and even from day to day, but that this variation takes place as much in the early as in the later periods of lactation. We are not warranted, therefore, in assuming that the milk grows stronger as its age increases, provided that it still remains in normal equilibrium. The mammary gland acts both as a secretory and as an excretory organ, so that it cannot be classed as a metabolic tissue in the limited meaning which we now attach to these words. Yet the metabolic phenomena (Foster) giving rise to the secretion of milk are so marked, so distinct, and have so many analogies with the metabolism which we meet in adipose tissue, that we must look upon the mamma chiefly as a secretory organ. This, however, is only within certain limits, for we know that at times foreign elements may be excreted from the gland. This at once suggests the interesting question as to when the mammary gland is most likely to have what we might call its normal secretory function interfered with and to assume temporarily the function of an excretory organ. This seems to occur both before the gland has attained its equipoise, as during the colostrum period, and later when any of the above-mentioned influences occur which affect the general mechanism of the gland. In these instances we find the colostrum reappearing in the milk. Therefore in the beginning of lactation, during lactation when normal metabolism is interfered with, and as lactation draws to a close, we have analogous conditions in which the mammary gland instead of being a normal secretory organ becomes abnormal and more or less an excretory organ. During these periods of abnormal gland excretion we must remember that drugs can be eliminated by the milk more freely than when the gland is in equipoise. We assume, therefore, that the mamma during that early period of lactation, which essentially represents a condition of lack of equipoise, has a double function, partly secretory, partly excretory. The greater the excretory function of the gland is at any time in proportion to the secretory, the more abnormal will be the finished product; while the nearer the gland approaches to a purely secretory organ, the more perfect and normal will be its product. The mechanism of the mammary gland is therefore in its most perfect condition after the colostrum period has ceased, and at a time when the general organism, both physical and mental, is freed from causes detrimental to a perfect metabolism.

General principles are vital in their importance when we come to study the subject of feeding in all its phases, whether the nutriment to be provided for the infant is to come directly from its mother, a wet-nurse, or an animal, or indirectly from the product of the mammary gland. These principles are, (1) That nature throughout all ages has clearly indicated by means of natural selection what the source of supply should be; that is, that the mother should during some early period of its life supply food for her offspring from her mammary glands. (2) That where, owing to disease, over-civilization, or any causes which prevent the offspring from receiving its sustenance directly from the maternal mammae, some nutri-



ment must be substituted which will correspond as closely as possible to the natural food-supply. (3) That this substitution can be obtained most exactly through the product of the mammary gland of another woman. (4) That, owing to the strong analogy between human beings and all animals which suckle their young, we should in our study of copying good human milk make use not only of what we have learned from human beings, but also of what is known of lactation as it occurs in animals. This entails acquiring a knowledge of the investigations and experience of those who have studied commercially the breeding of animals and their food, and the production and modification of their milk.

I have already explained to you the conditions which are normally found in early life from birth to puberty. All these conditions representing the various stages of a physiological development must be thoroughly understood and remembered if you wish to appreciate the many difficulties which are to be dealt with in a practical investigation of infant feeding. In my next lecture I shall begin the consideration of feeding during the first twelve months of life. This I have designated as "*The First Nutritive Period.*"

## LECTURE VII.

## THE FIRST NUTRITIVE PERIOD.

## I. MATERNAL FEEDING—II. DIRECT SUBSTITUTE FEEDING—III. INDIRECT SUBSTITUTE FEEDING.

As in my lecture on Development I endeavored to emphasize only those facts which would be of practical use to you from a clinical stand-point, so, in dealing with the subject of nutrition, I shall not attempt to discuss the finer and more intricate questions of physiology and chemistry. While expecting to receive great aid from the physiological chemistry of the future, we must not allow this fascinating branch of our art prematurely to set aside evident clinical truths which for years have emanated from nursery practice and have proved to be of great value in it. The nutrition of young human beings may be divided into three distinct nutritive periods, corresponding to the degree of their development. The first period consists of the first ten or twelve months of life. The second period comprises the second and third years, and the third period the remaining years of childhood. The science of feeding depends almost exclusively, in addition to the general principles of which I have already spoken, on the knowledge of what elements of the food are required by the growing tissues in these nutritive periods, and also on the time when the various digestive functions are ready and able to dispose of them. I shall therefore begin with the discussion of the first nutritive period, which is essentially the only one where human milk need be considered. I have already referred to the marked analogy which exists between the nutrition of human beings and other mammals, and the necessity of understanding the lactation of animals when we endeavor to explain that of human beings. In order to acquire this knowledge I have received so much aid from Mr. G. E. Gordon that I wish to acknowledge my indebtedness to him for placing at my disposal the fruits of his many years of study and practical observation on the feeding, breeding, and lactation of cows.

The first nutritive period, which for purposes of simplicity I have arbitrarily made to represent the first twelve months of life, is obviously, from what I have already told you, the most important one of the three. In this period the infant may be fed by a number of methods. It may be nursed by its mother, or a wet-nurse, or an animal, or it may be nourished by food especially prepared from the milk of one of these.

**I. MATERNAL FEEDING.**—The first of these methods, the *maternal*, is so far superior to any other which has ever been known that I shall assume that it is the best, and the one from which in almost every particular all others should be copied.

The relative advantage of the milk-supply received from a primipara or a multipara is not of so much importance in the case of mothers as in that of wet-nurses. I shall therefore defer what I have to say on this subject until I speak of the latter, merely reminding you of what I have told you concerning them in a previous lecture (Lecture IV., page 100).

**NORMAL MATERNAL CONDITIONS.**—The assumption that the maternal is when normal the ideal source of infant food-supply presupposes many important conditions concerning the mother and the function of her mammary glands. She should be strong and healthy, of an even, happy temperament, desirous of nursing her infant, and have time to devote herself to this special duty during the whole period of her lactation. She should have a sufficient supply of milk, and should be willing to regulate her diet, her exercise, and her sleep according to the rules which will best fit her for her task. These may be said to be the ideal conditions which we endeavor to obtain for an infant which is to be nursed under the most favorable circumstances. It is true that women who are far from vigorous nurse their infants with seemingly good results, and that a frail, delicate-looking mother may have an abundant supply of good milk. These are exceptions, however, which make the principles just stated all the more true. We must have some general principles to guide us in our endeavor to perfect the nutriment of infants as a class, or we shall surely in many instances do serious harm to the individual.

**CONTRA-INDICATIONS TO MATERNAL FEEDING.**—With few exceptions, the mothers who have uncontrollable temperaments, who are unhappy, who are unwilling to nurse their infants, who are hurried in the details of their life, who are irregular in their periods of rest and in their diet and exercise, are unfit to act as the source of food-supply for their infants. Even if their milk happens to be sufficient in quantity, it will probably be so changeable in quality as to be a source of discomfort and even of danger rather than the best nutriment for their offspring. It is far better for such mothers not to attempt to nurse, but to adopt some other method of feeding. It is of still greater importance that mothers who are suffering from some chronic disease, or one which their infants may directly inherit, should give up all thoughts of nursing. Where there is no question of disease in the mother, it is our duty to investigate, and, if possible, to counteract the other contra-indications to nursing, often only caused through ignorance of what to us seem very simple truths, but which to the young mother are enveloped in mystery. There is, then, a double necessity for studying in the closest detail the conditions which constitute a normal lactation. First, that, knowing what is normal, we should at once recognize what is abnormal, and, by the intelligent use of our knowledge, render possible an apparently unsuccessful attempt to nurse. Second, that we may know exactly on what the normal and vital conditions of a successful nursing depend, in order that we may understand what we should copy in substitute feeding.



It is these normal and vital conditions which I shall endeavor to explain to you, and which, for the reasons just stated, you must not look upon as trivial, for I have found them of the greatest value both in the management of human-breast milk and in the regulation of infant feeding. The *maternal*, then, being the ideal method, I shall begin by showing you an actual illustration of this method.

NURSING MOTHER.—Here is a young mother (Case 60), perfectly healthy and strong, in the act of nursing an infant.

CASES 60 AND 61.



Infant 5 months old. Weight, 9800 grammes (about  $21\frac{1}{2}$  pounds). Birth-weight, 4500 grammes (about 10 pounds).

The infant (Case 61) was healthy at birth, and has grown continuously, with regular weekly gains of about 250 grammes (about  $\frac{1}{2}$  pound). Its birth-weight was 4500 grammes (about 10 pounds), and it now weighs 9800 grammes (about  $21\frac{1}{2}$  pounds). It is a fine specimen of normal development produced by human milk, and is so large that it has had to be dressed in short clothes some months earlier than is usual. You will observe that this normal nutrition depends in great measure on its birth-weight rather than on any phenomenal gain which it has made from month to month. You will understand this by referring to what I have said regarding weight in my lecture on Development (Lecture IV., page 103), where I have stated that the birth-weight is normally doubled in the first five months of life. I would also call your attention to what I shall speak of more in detail later, that it is not necessarily a milk of unusually good percentage which has produced this progressive increase in weight. It is merely a good milk adapted to the especial need of this particular infant, and it might not at all suit a number of other equally healthy infants. This fact, as you will soon understand, merely declares that practically there is no one combination of the elements in human milk which is the best for all infants, but that nature pro-

vides a number of combinations all equally good provided that they are suited to the individual.

You see that the natural method of feeding is by sucking. The infant should be placed in a comfortable position in its mother's arms, with its head and back supported. It should be made at once to understand that it is to begin its meal as soon as the breast is offered to it, and continue, with, of course, breathing-spells, until the meal is finished. The mother should herself preferably be sitting, as she can thus best manage and control the infant if it is inclined to be restless.

Now notice more closely the method by which this infant is obtaining its food. The formation of its lips and buccal cavity are adapted to the mechanism of suction, and you see with what ease and perfect tranquillity it is receiving its food. The breast is so organized that it provides a fresh supply of food at the required intervals. It prevents fermentation of the food before it enters the infant's mouth, while at the same time the suction incites to action both the necessary digestive fluids of the infant and the function of the gland itself. The gland avoids a vacuum by collapsing as it is gradually emptied, and allows the food to flow continuously, thus obviating the tendency to exhaustion of the infant and prolongation of the nursing-time which necessarily accompanies a retarded flow of the milk. Finally, the breast is practically self-regulated as to the amount which it is required to provide according to the infant's age. A healthy infant should empty the breast with easy and uninterrupted sucking in about fifteen to twenty minutes.

**NIPPLES.**—In certain cases the mother's nipple is so small or depressed that it is a source of much annoyance to the infant, and at times this interferes so seriously with its obtaining the proper food-supply that its nutrition suffers, and some other method than nursing has to be substituted. It is here that the ingenuity of the physician is taxed to its utmost. Every kind of device may fail, and it is necessary patiently to try one after the other before deciding to give up the nursing. Nipple-shields should be experimented with, and will sometimes obviate the difficulty. We should, however, always impress upon the mother the fact that the value of her milk as a food may be entirely destroyed if foreign elements are allowed to enter with it into her infant's mouth. This simply means extreme cleanliness of the glass shield and rubber nipple. In a few cases where I could absolutely trust the mother on account of her being able to appreciate intelligently the details of my instructions and the danger of not carrying them out, I have allowed, for a short time, the use of rubber tubing connected with the nipple-shield in place of the direct attachment of the rubber nipple. When this is done, however, fresh tubing should be used every day, as it is extremely difficult to cleanse the interior of a rubber tube as one can the rubber nipple, which can be turned inside out and scrubbed. I would, however, decidedly state that I consider, except in these rare instances, the use of rubber tubing to be an abomination which should never be tolerated under other circumstances, and especially in feeding from the bottle, where its use is absolutely unnecessary.

Where the nipples are very tender and cause great discomfort to the mother during the nursing, their condition frequently becomes so serious an obstacle as to prevent nursing altogether. This change, however, should not be thought of for at least several days, or until it is absolutely certain that the exquisite pain is more than the mother is willing or able to endure.



It is often the case that after a little time of the greatest suffering from tender or excoriated nipples the whole difficulty will pass away and the mother be able to nurse her infant with comfort. I know of no especial treatment which will prevent this condition of the nipples from arising, nor of any way by which it can be quickly cured. Bathing with cold water before and after the nursing, and thus keeping the tissues in a healthy condition, appears to be as successful as the application of any medicaments.

**MASTITIS.**—Another trouble which may arise during the nursing period is a disturbance of the mammary gland itself, sometimes amounting merely to a stasis in its milk production, but again going on to inflammation. The latter is a serious matter, and should at once be placed in the hands of a skilful surgeon. The former condition requires great care in its management. Gentle massage from the periphery of the gland towards the nipple, amounting in fact to merely a delicate stroking with the ends of the fingers, is an important part of the treatment. The breast should be withheld from the infant for about twenty-four hours, and the milk from time to time drawn in small quantities by means of a properly-adjusted breast-pump. The breast should also be carefully supported by a swathe. If these measures are begun as soon as there are any indications of disturbance in the breast, these abnormal conditions soon disappear. The indications referred to consist in the appearance of hard swellings in place of the usual soft elastic condition of the milk glands. These swellings may occur without any especial pain, but on palpation they are usually tender to a greater or less degree.

**BREAST-PUMP.**—In regard to the use of the breast-pump there is a great difference of opinion, but I have very decided views on this subject, and believe that those who have opposed its use have been influenced to a great degree by what they have seen in their hospital practice, and also by the views of others who have, in like manner, met with unfortunate results in lying-in hospitals. It is well known that all inflammatory conditions about the breast are more likely to occur in hospitals than under conditions where the woman is less likely to be exposed to pathogenic organisms. This should be taken into account when we are deciding whether or not to use a breast-pump. In my experience, acquired in a great degree from my private practice, where every precaution in regard to cleanliness, fresh air, and good ventilation could be obtained, I have never met with any bad results from the use of the pump.

In regard to the relation of micrococci to inflammation of the breast, according to Zweifel and Döderlein there are in mastitis two varieties of organisms, the *staphylococcus pyogenes aureus* and the *streptococcus pyogenes*, but never the *staphylococcus pyogenes albus*. They admit that other varieties may perhaps be found on closer investigation, but at the same time they consider it striking that in all their cases there were never any local or general symptoms caused by the *staphylococcus pyogenes albus*, although that they were virulent was proved by their inoculation of mice. There



is not much doubt that these pathogenic organisms gain access to the gland through the nipple.

I have already said that the infant may not be able to hold the nipple with sufficient firmness on account of some abnormal condition of the nipple itself.

Under certain circumstances, even where the nipple is well formed, the infant has insufficient suction-power to obtain its food, though the food itself may be perfectly adapted to its digestion. In these cases we often find that it cannot or will not be induced to obtain its food through a shield and rubber nipple or from rubber tubing. The breast-pump may then become of great value, as in the case of an infant that was under my care during the hot weather of June, July, and August.

This infant (Case 62) was seven months old, and was dying of starvation, as I had not been able to prepare for it a food which it could digest and thrive on. (This was before milk laboratories were established.) It was totally unable to nurse, although the breast-milk was a good one and agreed with it perfectly when it was introduced into its mouth with a spoon. The milk was pumped from the breasts at regular intervals and given to it from a bottle for over three months with the greatest success, the infant thriving, and at the end of that time being in a perfectly healthy condition.

This case shows the exceptional but at times very great value of the breast-pump.

As I shall later have occasion to speak of the use of the pump in various instances, not only for relieving the breast but for obtaining milk for purposes of analysis, I will show you the form of pump which I am in the habit of using (Fig. 40).

The apparatus should be one which can be carefully cleansed, and should, therefore, preferably be made of glass. No one special pump will, in all probability, suit every case, and it is of importance that you should use the greatest care in adapting the pump to the individual. As I have stated, however, this is the one which in most cases I have found to be suitable. When applied to the woman it should cause little or no pain or discomfort. You see that the part which is adapted to the nipple is like an ordinary nipple-shield. This is attached to a glass bulb, into which the milk falls as it is drawn from the breast. The mechanism is very simple. A vacuum can be produced in the glass bulb by means of suction through a rubber tube attached to a rubber bulb with its valve working backward. This is a far better method for producing

FIG. 40.



Breast-pump.

suction than the direct application of the mouth to the end of the rubber tube, which under all circumstances should, if possible, be discountenanced.

**MILK.**—The product of the mammary gland of all mammals is essentially the same. It is composed of elements which in an individual milk resemble the corresponding elements in all the others. Although the attempt has long been made, and may in the future prove to be successful, to distinguish between the component parts of each element, yet at present we must, with few exceptions, accept each element as a whole and as alike both in human beings and in animals. This must practically be done until the analytical and physiological chemists provide us with much more exact data on which we can depend in elaborating our methods of infant feeding. It is the combination of the various elements of the mammary gland which makes the resulting product characteristic of the special mammal, and it is therefore best first to describe this uniform product as a whole and then to study it as it occurs in its various combinations, whether in human beings or in animals.

In addition to the general principles which I explained to you in my last lecture, a number of physiological facts regarding milk as a whole become of great interest and of the utmost importance when we attempt to modify or change the product of the mammary gland.

**FORMATION.**—Bunge's investigations on the comparison of tissues show that the mammary gland abstracts from the blood very nearly the amount of salts found in the tissues. According to Foster, whose remarks on this subject I quote freely, milk is the result of the activity of certain of the protoplasmic cells occurring in the epithelium of the mammary gland. So far as we know, the fat is formed in the cell through a metabolic action of the protoplasm. Microscopically, the fat can be seen to be gathered in the epithelial cell in the same way as in a fat-cell of the adipose tissue, and to be discharged into the channels of the gland either by a breaking up of the cells or by a contractile extrusion very similar to that which takes place when an amoeba ejects its digested food. This observation is thoroughly supported by other facts. Thus, the quantity of fat present in the milk is directly increased by proteid food, but is not increased by fatty food; on the contrary, it is diminished. In fact, proteid foods increase and fatty foods diminish the metabolism of the body. A bitch fed on meat for a given period gave off more fat in her milk than she could possibly have taken in her food, and that, too, while she was gaining in weight, so that she could not have supplied the mammary gland with fat at the expense of fat previously existing in her body. We also have evidence that the caseinogen is, like the fat, formed in the gland itself. When milk is kept at 35° C. (95° F.) outside of the body the caseinogen is increased at the expense of the albumin. When the action of the cell is imperfect, as at the beginning and end of lactation, the albumin is in excess of the caseinogen; but so long as the cell possesses its proper activity, the formation of caseinogen becomes prominent. That the milk-sugar also is formed in and by the protoplasm of the cell is indi-



cated by the fact that the sugar is not dependent on a carbohydrate food, and is maintained in abundance in the milk of carnivora when these are fed exclusively on meat as free as possible from any kind of sugar or glycogen. We thus have evidence in the mammary gland of the formation, by the direct metabolic activity of the secreting cell, of the representatives of the three great classes of food-stuffs, proteids, fats, and carbohydrates, out of the comprehensive substance protoplasm.

NERVOUS DISTURBANCES AFFECTING THE MILK.—The secretion and ejection of milk are very evidently under the control of the nervous system, which produces marked changes in both the quantity and the quality of the mammary product in proportion to the relative nervous excitability of the special mammal. Women are especially sensitive in this respect, and when living in the midst of our modern civilization, so harmful for the production of good nursing, present an exaggerated example of disturbance of the equipoise of the mammary gland. The chemistry of the equipoise and lack of equipoise of the mammary product appears to be closely connected with its proteid element. This element is known to be a compound one and decidedly complex, but for purposes of illustration we can safely say that the word albuminoid or proteid is a general term, which includes caseinogen and albumin; also that these factors of the complete whole vary in their proportions to each other according as the mammary function is or is not in a state of equipoise. In the colostrum period, and probably in the analogous periods represented by the abnormal conditions already spoken of, the albumin is in excess in proportion to the caseinogen, while as the equipoise of the function becomes more complete the caseinogen is increased proportionately to the albumin. Probably at the end of lactation, as in the beginning, we shall find this same condition of richness of albumin and deficiency of caseinogen. This increase of the albumin at the expense of the caseinogen explains what I have previously told you concerning the excretory function of the gland at times becoming more prominent than the secretory.

These nervous disturbances, however, may also cause, as I shall describe to you later, an over-production of the total proteids, as shown by their percentages. In some cases also the fat has been found to be much reduced in its total percentage. Instances of this have arisen where, as observed by Zukowski and quoted by Jacobi, seasons of fasting with their accompanying excitement of the emotions have induced such a disturbance of the equilibrium of the milk that the fat has been found to be decreased to the low percentage of 0.88, with the result that the infant has become sick and given evidence of impaired nutrition. These same nervous influences in all probability have to a greater or less degree their analogy in the milk-product of all mammals.

CONSTITUENTS AND PROPERTIES.—Milk consists of a large amount of water and a comparatively small amount of solids. The solid constituents comprise, in varying proportions, certain *proteid* elements, *fat*, *sugar*, and *mineral matter*.



"Milk is an emulsion, the fats existing in the form of globules of varying but usually minute size. It is this condition of the fat which gives milk its peculiar white color." (Foster.)

The *specific gravity, reaction, and other properties* can best be spoken of when describing the milk of an especial mammal.

The closely analogous conditions, however, of the earliest days of lactation in the woman and in the cow lead me to describe in my general remarks on milk the *colostrum period* of these two mammals.

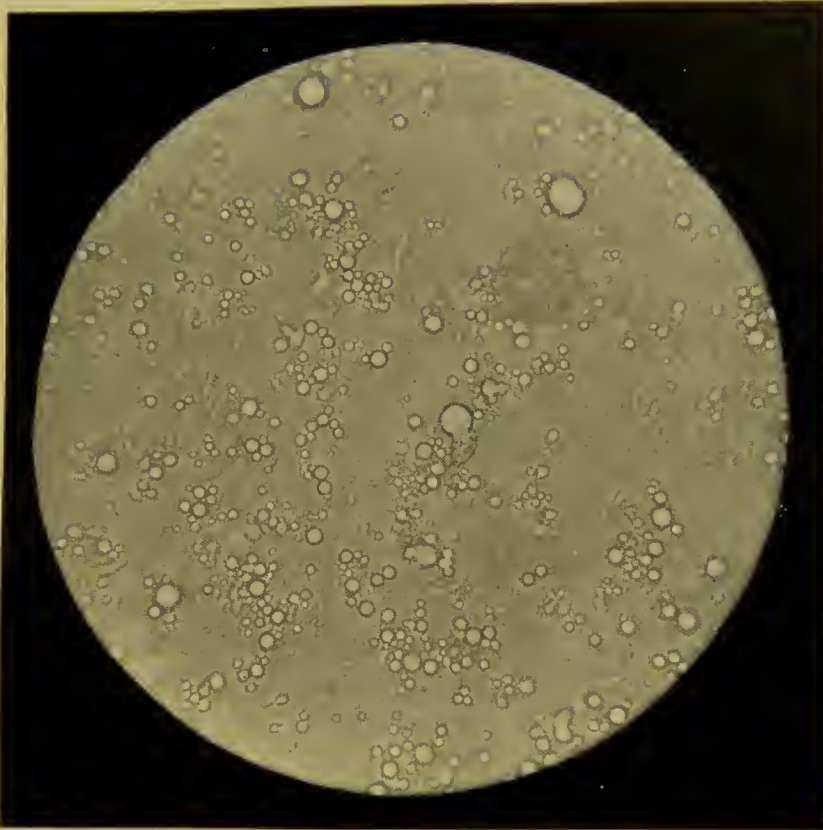
COLOSTRUM.—During the early days of lactation the mammary gland secretes a somewhat different fluid from that which is produced by it later. The milk at this period is called *colostrum*, and the period is called the *colostrum period*, on account of certain elements called *colostrum corpuscles* which are present in the milk. I have already spoken of the connection between loss in weight of the infant (Lecture IV., page 100) and the presence of colostrum in the milk; also of the excess of albumin over the caseinogen in colostrum milk.

Colostrum is supposed to have a somewhat laxative effect, and in this way to aid in displacing the meconium. Whether it is of any especial advantage to the infant is a question of much doubt, for it appears to me, and it will, I think, be understood by you, from what I have already told you regarding the mammary gland, that the appearance of these colostrum corpuscles is simply an indication that the equilibrium of the mammary gland has not been established, or has been disturbed, and that it is an evidence of disease rather than of health. It may be that the not infrequent disturbance of the infant's digestion, amounting at times to acute conditions of fermentation, is produced by an exaggerated abnormal condition occurring in the colostrum period as well as by the return of the colostrum at irregular periods. This may be the reason why numbers of infants are made sick by their mothers' milk at an early period of lactation.

The analysis of colostrum milk is something which as yet has not been thoroughly studied. Whether it will be of much importance or not is a question to be determined in the future. It may, however, prove to be of considerable use to us when we attempt to prepare a substitute food for the early days of life. It is possible that a combination of elements corresponding in their percentages to those which are shown by the analysis of the colostrum, but free from the colostrum corpuscles, may be found to suit best the infant's digestive function at this early period of its life. I have under one of these microscopes a drop of colostrum milk (Fig. 41) taken from a cow, and under the other a drop (Fig. 42) taken from a woman.

In addition to the fat-globules of various sizes which you see floating in this film of milk you will notice the large cells which occasionally appear in the field. These are the colostrum corpuscles. The one to the right above the centre in the cow's milk appears to be about one-third larger than the one to the left and below the centre in the woman's milk.

FIG. 41.



Colostrum milk from cow. (Photo-micrograph.)

FIG. 42.



Colostrum milk from woman. (Photo-micrograph.)





An analysis (Analysis 6) made by Dr. Harrington of this cow's milk colostrum gave the following results :

## ANALYSIS 6.

Fat . . . . .	1.71
Milk-sugar . . . . .	4.90
Proteids . . . . .	1.72
Ash . . . . .	0.79
Total solids . . . . .	9.12
Water . . . . .	90.88
	100.00

This table (Table 33) represents the analyses of some specimens of human colostrum milk, which I have also had made by Dr. Harrington :

TABLE 33. (Harrington.)

	I.	II.	III.	IV.	V.
Fat . . . . .	1.40	0.68	2.40	5.73	4.40
Milk-sugar and proteids . . .	9.44	11.53	11.15	10.69	11.27
Ash . . . . .	0.17	0.31	0.25	0.16	0.21
Total solids . . . . .	11.01	12.52	13.80	16.58	15.88
Water . . . . .	88.99	87.48	86.20	83.42	84.12
	100.00	100.00	100.00	100.00	100.00

These analyses, while not determining minutely the percentages of the elements of colostrum milk, tend to show the great variations which occur in this period and how little knowledge we have concerning it.

In speaking to you about the colostrum in my lecture on normal development (Lecture IV., page 100) I stated that the colostrum corpuscles should disappear from the milk in a week or ten days after birth. They diminish rapidly in numbers during the second week, and if they continue into the third week, or return at any time during the lactation, they almost invariably cause disturbance of the infant's digestion; they also become an indication that lactation should be suspended temporarily, and, if they continue, that it should be entirely given up.

On the disappearance of the colostrum corpuscles the milk should rapidly acquire its normal equilibrium, and, with the exception of its well-recognized daily variation, should show a comparative uniformity in its analysis during the whole of the nursing period, and until the equilibrium of the mammary gland is again disturbed, as at the end of lactation.

**HUMAN MILK.**—I have stated the general conditions which affect the mammary product of all animals. I will now describe especially what is known concerning human milk.

**QUANTITY.**—I have already told you how the mammary gland adapts its quantity to the amount needed. The question so often arises as to whether the total amount to be secreted for each feeding can in any way be increased, that it is well to mention this now and to dispose of it. Beyond the general conditions affecting the mammary product of the mother, which I have spoken of, I know of no means of increasing the flow of milk. I

have little confidence in galactagogues in the form of drugs or special foods, for their numbers betray their inefficiency. The milk becomes lessened in amount from many causes. Some of these are identical with those which commonly produce any disturbance of its equilibrium such as I have mentioned. Certain drugs, such as belladonna, will in some individuals cause a notable decrease in the flow of the milk, and must, therefore, be given with care during the nursing period. An active cathartic will also lessen the milk, as will also a diet composed of solid food and very little water.

QUALITY.—The quality of the mother's milk is of the utmost importance to the welfare of the infant. It is very necessary, therefore, that we should thoroughly investigate and clearly understand what the normal composition and characteristics of her milk should be. This can be done only by having analyses made by expert chemists. Even with the aid of these analyses the information which is obtained concerning the percentages of the various elements is liable to be inexact in some of them.

This is unfortunately true regarding the two elements fat and proteids, which are under any circumstances the ones most likely to vary, and we must especially allow for some slight error in the proteid percentage.

The greatest practical assistance, however, can be obtained from these analyses, as they represent the true foundation for most of our work on infant feeding. I shall not attempt to describe the method of analysis which is used, as it is too purely a chemical question to be of practical use in clinical work.

My analyses have in almost every case been made by Dr. Charles Harrington. To obtain a specimen for analysis your hands should be sterile, and the breast and nipple should be carefully washed with sterilized water, and from 20 to 30 c.c. (5 to 8 drachms) of milk drawn by the breast-pump, which, being made of glass, can also be thoroughly washed. The milk should then be poured into a sterilized bottle and tightly corked. It should immediately be taken to the chemist, and kept on ice until the examination is made.

In every case it is very important to know the exact percentage of the fat, both from its being the most variable element and from its use in the determination of the percentages of the other elements. Any means, therefore, which will procure the exact percentage of the fat should be made use of where for any reason a complete analysis cannot be procured. The most exact means for this purpose outside of the chemical laboratory is an apparatus called the *Babcock Fat Tester*, which I shall show and explain to you at the Milk Laboratory in a later lecture (Lecture IX., page 250). As this is not an expensive machine, it has seemed to me that in communities at a distance from an expert chemist, or where the people are unwilling to pay for a complete analysis, a Babcock machine could be owned jointly by a number of physicians and kept at some central place.

The smallest amount of milk required for determining the percentage of fat with the Babcock machine is 17.50 c.c.



**NORMAL LACTATION.**—In order to understand the many variations which are continually arising in human milk during the period of what may be considered a normal lactation, we should clearly appreciate the various conditions existing in human milk and its composition as determined by a study of a very large number of individual specimens of milk. In this way we obtain a knowledge of the composition of the average human milk.

**MICROSCOPIC EXAMINATION.**—The mere microscopic examination of milk beyond the determination of the presence or absence of colostrum corpuscles and foreign matters, such as pus, blood, and epithelial cells, is too uncertain and misleading to be in any way depended upon, the chemical analysis being the only practical method which can be recommended. The truth of this statement was lately impressed upon me when a physician skilled in the use of the microscope sent me a specimen of woman's milk which he stated was rich in fat, but which the analysis showed to have only a little over one and a half per cent. of this element.

The presence of an undue amount of yellow coloring matter is at times very misleading. I have also seen human milk which had a greenish color, evidently produced by some of the micro-organisms which are known to occur in cow's milk, but the nature of which is not yet fully determined and which under the microscope are not represented by anything abnormal.

**CLINICAL EXAMINATION OF HUMAN MILK.**—The rules by which the percentages of the other elements of the milk can be deduced when once the percentage of the fat has been obtained by the Babcock machine are the same as those which I shall presently speak of in connection with another method of clinical examination, where, however, the determination of the fat is not so accurate as that by means of the Babcock. We cannot be too particular in regard to the accuracy of the method which we employ for obtaining an analysis of the milk; yet, as the most accurate analysis can be obtained only through an expert chemist, a simple approximate clinical test is often very desirable, even though it is less accurate. Under these circumstances the method employed by Dr. L. E. Holt, of New York, will be found to be of practical use. Holt does not assert that he reaches by his method anything but a fairly accurate knowledge of the percentages of the different elements of the milk, and he recommends it for the analysis of human milk only where a better one cannot be had. His results are based upon the comparative examination by his method of a large number of specimens of milk and on the following well-known chemical facts:

(1) That the *specific gravity* of human milk varies between 1029 and 1032, the average being 1031, at 21.11° C. (70° F.). Abnormal variations occur between the limits of 1017 and 1036. An increase in the fat lowers the specific gravity; an increase in the other solids raises it.

(2) That the *salts* do not vary much in their amount in ordinary human milk. They are too insignificant in percentage to affect the specific gravity, and in the clinical examination of milk they need not be considered.



(3) That the proportion of the *sugar* is nearly constant in human milk under all circumstances. This point has been emphasized by all the chemists who have made milk analyses.

(4) That in striking contrast to this uniformity in the sugar are the wide variations met with in the *fat* and *proteids*, as is shown by the following tables :

TABLE 34.  
*Variations in Fat.*

From 43 analyses by Leeds . . . . .	2.11 to 6.89 per cent.
“ “ “ König . . . . .	1.71 to 7.60 “ “
“ 29 “ “ Chem. Lab. Coll. Phys. and Sur. N. Y. .	1.12 to 5.02 “ “

TABLE 35.  
*Variations in Proteids.*

From 43 analyses by Leeds . . . . .	0.85 to 4.86 per cent.
“ “ “ König . . . . .	0.57 to 4.25 “ “
“ 29 “ “ Chem. Lab. Coll. Phys. and Sur. N. Y. .	1.10 to 3.62 “ “

(5) That to determine the composition of milk we must have a knowledge of the *proportions* in which the two elements which vary most widely, namely, the *proteids* and the *fat*, are present.

(6) That from the fact that the proportion of sugar is so nearly constant and that the salts are in such small amounts, we may for clinical purposes consider the *specific gravity* as *modified* solely by the *fat* and the *proteids*.

(7) That there is no known method of determining directly the percentage of the proteids in the milk by a clinical examination, and that a complete chemical analysis by an expert is the only one that can be accepted as accurate. It is possible, however, from a knowledge of the specific gravity and the percentage of the fat, to make an approximate calculation in regard to the percentage of the proteids, at any rate sufficiently close to determine whether in a given case they are near the normal, or are in very large or very small proportions.

METHOD OF EXAMINATION.—It is necessary first to determine the specific gravity of the milk and the percentage of the fat.

To determine the composition of the milk by Holt’s method the only instruments needed are a small hydrometer, a pipette, and a glass-stoppered cylinder graduated in one hundred parts and holding about 10 c.c.

The specimen of milk for analysis should be taken from the “middle milk,” and it is important that the milk should be freshly pumped and handled as little as possible, also that the graduated glass cylinder should be scrupulously clean, otherwise the milk will often sour before the cream has had time to rise. This is particularly true in summer. 15 c.c. ( $\frac{1}{2}$  ounce) is the amount of milk required for the test.

Specific Gravity.—The specific gravity is obtained by means of the hydrometer, for the use of which only 15 c.c. ( $\frac{1}{2}$  ounce) of milk are needed.

Percentage of the Fat.—The percentage of the fat is determined

by estimating the percentage of the cream, which is ascertained by the following method :

The glass-stoppered cylinder is filled with milk exactly to the upper line, which is marked 0. The pipette should be used for putting the last few drops into the cylinder, care being taken not to allow the milk to run down the inner side of the tube, since this somewhat obscures an exact reading. The cylinder is then corked and allowed to stand for twenty-four hours at a temperature of as nearly  $21.11^{\circ}\text{C}$ . ( $70^{\circ}\text{F}$ .) as is practicable. A variation of a few degrees on either side of this point is unimportant. If, however, the variations are wide, the rapidity with which the cream rises is somewhat modified.

In the great majority of cases the lower line of the cream has become sharply defined at the end of twenty-four hours, and can then be recorded. If this is not the case, the milk should be allowed to stand for six hours longer before reading the percentage.

By comparing the percentage of the cream with that of the fat, as determined by a chemical analysis of the same specimen, it has been discovered that the ratio of the cream to the fat is very nearly 5 to 3, and for clinical purposes it can be so estimated.

**Estimation of the Proteids.**—In estimating the proteids certain suppositions must and can be fairly accepted :

(1) Supposing the proteids to remain unaltered : if the percentage of fat be low, the specific gravity will be high, but if high, the specific gravity will be low.

(2) Supposing the fat to remain unaltered : if the percentage of the proteids be high, the specific gravity will be high, but if the percentage of the proteids be low, the specific gravity will be low.

If, therefore, the fat and the specific gravity be known, the proteids may be estimated by the following rules :

(1) If the percentage of the fat be found to be high and the specific gravity high, that is, from 1033 to 1034, we may assume that the proteids are also of high percentage, otherwise the excessive fat would bring the specific gravity below the normal average.

(2) If the fat be found to be of low percentage and the specific gravity high, we may assume the proteids to be nearly normal, since the high specific gravity is explained by the small proportion of fat.

(3) If the percentage of fat be high and the specific gravity low, the proteids may be assumed to be normal, since the variation in the specific gravity is explained by the high percentage of fat.

(4) If the percentage of fat be low and the specific gravity low, the percentage of the proteids is also low, since otherwise the small proportion of fat would make the specific gravity above the average.

Of course it is only the wide variations in the proteids which can be recognized by these rules ; but these variations are often very important.

We can then say that, knowing the specific gravity and calculating the fat as three-fifths of the known percentage of the cream, we can judge whether the proteids are nearly normal, very high, or in very small amount. Holt asserts that the estimation of the composition of milk by this method is as exact as that obtained by ordinary examinations of urine.

CHEMICAL ANALYSES.—There is no doubt of the great value of an expert chemical examination of the milk in cases where an infant is not thriving, although apparently receiving a sufficient quantity of milk from its mother. On the other hand, you must remember that a chemical analysis will never give any information regarding the quantity of the milk, and it often happens that where such an analysis has proved the quality to be good, the infant is not thriving because the quantity of the milk is very small. The symptoms which indicate that it is the quantity of milk which is at fault rather than the quality are that the breasts at the nursing time are soft, and that only a small quantity of milk can be extracted from them by the breast-pump. A period of nursing longer than the usual fifteen to twenty minutes before the child is satisfied should make us suspicious that the milk is lacking in quantity. We can also determine the actual quantity of the milk which the child has imbibed at an especial nursing by means of weighing, as described in a previous lecture (Lecture IV., page 79). A number of observations at different nursings in the day must, however, be made before a correct conclusion can be reached by this latter procedure.

AVERAGE ANALYSIS OF HUMAN MILK.—I will now call your attention to this analysis (Analysis 7) of average human milk, which represents the work of such chemists as König, Forster, Meigs, Harrington, and others, and the mammary product of a large number of women of all nationalities. The figures opposite each element are the percentages which that element represents as a part of the total solids, without reference to its own composition.

ANALYSIS 7.

*Average Human Milk.*

Reaction . . . . .	Slightly alkaline.
Specific gravity . . . . .	1028-1034
Water . . . . .	87-88
Total solids . . . . .	13-12
Fat . . . . .	3-4
Sugar . . . . .	6-7
Proteids . . . . .	1-2
Total ash . . . . .	0.1-0.2

You can obtain from this analysis a fair knowledge of the normal composition of human milk, and you will at once notice its simplicity and its few constituents.

Reaction.—The normal reaction of human milk when freshly drawn with suitable precautions is, as a rule, alkaline; it is, however, sometimes neutral, rarely acid, and in the latter case it may be considered abnormal.

Specific Gravity.—The specific gravity varies normally to a considerable



degree on account of the variations in temperature to which the milk happens to be exposed at the time when the specific gravity is taken. When, however, the milk has its average normal composition, and the temperature to which it is exposed is  $15.50^{\circ}$  C. ( $60^{\circ}$  F.), its average specific gravity is 1031.

**Water.**—One of the most important chemical facts to be remembered for clinical purposes is the very large proportion of water which is found in normal human milk, for it teaches us that it is a highly diluted food by which the best results can be obtained in infant feeding. It also explains to us how careful we should be not to overtax the comparatively slight power for absorbing a concentrated food which exists in the early months of life.

**Fat.**—The fat of human milk is made up of palmitin, stearin, and olein. About two per cent. of the total fat consists of the glycerides of butyric, caproic, caprylic, and myristic acids. The production of animal heat is so very important a part of the infant's well-being that it is not surprising we should find so large a percentage of fat as well as of sugar in the food which is provided for it. The presence of fat in the milk is not only for the purpose of nutrition, but also as a means for the maintenance of bodily heat. This latter function of the fat cannot with impunity be trifled with, and is essential for that active metabolism of which I have spoken in an earlier lecture (Lecture IV., page 100). A proper amount of fat is probably of great aid in the regulation of the fæcal discharges. An amount of fat proportionate to the proteids is presumably necessary, or at least of great aid, in their proper digestion. We should naturally expect that unless the standard percentage of fat, or at least a near approach to it, existed in the mother's milk, trouble would be likely to arise with her infant, and this corresponds with my experience in cases where the special ingredient which has interfered with the success of the nursing has been the fat. I have found clinically that where the fat was much lessened the nutrition suffered, that the digestion was not good, and that there was a tendency to constipation, while where its percentage was decidedly above the standard the digestion was weakened, there was a tendency to diarrhoea, and in consequence a resulting poor nutrition.

These clinical observations at once suggest to us that in the management of infant feeding we must recognize the existence of two important conditions. One of these is the digestion of the infant, the other is its nutrition. These two requirements for a successful lactation are based on the facts that the milk may be easily digested but not nutritious, and that it may be highly nutritious but difficult to digest, so that it is the equilibrium of these two conditions which produces a perfect infantile development. It is especially important that the percentage of fat in an infant's food should be within the limits of the normal variations which are found in the milk of healthy nursing women with healthy infants. For, although it is admitted that a large percentage of surplus fat is frequently found in the fæces of

infants whose digestion and nutrition are normal, and whose food is human milk, yet we have no more right to conclude from this that a small percentage of fat is sufficient for nutrition, or that a large surplus will be eliminated by the fæces, than we have to assume that there is too much oxygen in the blood because we find a certain surplus of oxygen in the arterial blood which is returned to the lungs in the pulmonary veins. In fact, it is far more probable that nature introduces a certain percentage of fat into human milk with a purpose which can be accomplished only by that percentage, so that it is an error to change this percentage beyond the variation which commonly occurs in average human milk.

**Sugar.**—The form of sugar which is found in human milk is called milk-sugar, and, as you see by referring to this average analysis (Analysis 7), has the highest percentage of all the elements constituting the total solids of the milk. The sugar is more digestible than the fat, but does not have so much potential energy—that is, so much heat-producing power in a given weight—as does the fat, which is to the sugar as 2.4 to 1. The conversion of milk-sugar into lactic acid gives rise to many of the changes occurring in milk.

**Proteids.**—Although there have been a great many different opinions expressed as to the average percentage of the total proteids in human milk, we are led at present to believe that it is normally one or two per cent. The proteids or albuminoids, for the terms are synonymous, are general names including caseinogen and an albumin (lactalbumin), which in its general features resembles ordinary serum-albumin, but the chemistry of these elements is too obscure to make it worth while to consider them practically and clinically more minutely. We recognize that this albumin is present in small and variable quantities when the mammary gland and its secretion are in a normal condition, while at the time when the glandular function is being established, and during periods of glandular disturbance, it becomes proportionately larger in amount. I have already explained to you sufficiently the relative proportion under varying circumstances which the caseinogen and albumin bear to each other, and I will merely add to what I have already said, that the proteids, as a whole, are a valuable source of information to us when we are determining whether the milk is normal or abnormal.

**Ash.**—The ash, which is sometimes called the mineral matter and sometimes the salts, has an average percentage of from 0.1 to 0.2. Up to the present time, although a certain number of analyses of the ash of human milk have been made, yet the results, for various reasons, have been deemed unsatisfactory. So large a quantity of milk is needed for a reliable determination of the percentage of each element which makes up the total amount, that this in itself has been an important reason for failure in accuracy. The determination of the mineral matter of cow's milk has not been attended with the same difficulty, and its percentages have been estimated with comparatively reliable results. It has always been supposed that

there is a radical difference between the percentages of the mineral matter of cow's milk and that of human milk. The exact knowledge of the percentages which exist in the latter has become of still greater importance since such decided advances have been made in the modification of the elements of the former. With a view of making some advance in this difficult question, and of providing for the milk-modifiers of the future a more exact basis for perfecting a substitute food resembling as closely as possible the product of the human breast, I undertook, in the spring of 1893, to procure an unusual and sufficient quantity of human milk for analytical purposes. In the course of a few weeks, by means of the concerted action of numerous assistants, I collected five and a half liters (about six quarts) of human milk, which is an unusually large quantity for experimental purposes. This milk was immediately reduced to its mineral constituents in the laboratory of Dr. Charles Harrington. The analysis of this large amount of mineral matter was then made by Dr. Harrington and Dr. L. P. Kinnieutt, with the following results :

## ANALYSIS 8.

*The Ash of Human Milk.*

Unconsumed carbon . . . . .	0.71
Chlorine . . . . .	20.11
Sulphur . . . . .	2.19
Phosphoric acid . . . . .	10.73
Silica . . . . .	0.70
Carbonic acid . . . . .	7.97
Iron oxide and alumina . . . . .	0.40
Lime . . . . .	15.69
Magnesia . . . . .	1.92
Potassium . . . . .	24.77
Sodium . . . . .	9.19
Oxygen (calculated) . . . . .	6.16
	<hr/>
	100.54

*Composition of the Ash calculated from the above Analysis.*

Uncombined carbon . . . . .	0.71
Calcium phosphate . . . . .	25.35
Calcium silicate . . . . .	1.35
Calcium sulphite . . . . .	2.11
Calcium oxide . . . . .	1.72
Magnesium oxide . . . . .	1.91
Potassium carbonate . . . . .	24.93
Potassium sulphite . . . . .	8.04
Potassium chloride . . . . .	12.80
Sodium chloride . . . . .	23.13
Iron oxide and alumina . . . . .	0.40
	<hr/>
	102.45

A closer approximation to the relative proportions of the salts in the form in which they occur in milk, calculated from the above analysis, may be stated as follows :



Calcium phosphate . . . . .	23.87
Calcium silicate . . . . .	1.27
Calcium sulphate . . . . .	2.25
Calcium carbonate . . . . .	2.85
Magnesium carbonate . . . . .	3.77
Potassium carbonate . . . . .	23.47
Potassium sulphate . . . . .	8.33
Potassium chloride . . . . .	12.05
Sodium chloride . . . . .	21.77
Iron oxide and alumina . . . . .	0.37
	<hr/> 100.00

In comparing the previous analyses which have been made, and which can be found in König's *Nahrungsmittel*, II., 2<sup>e</sup> Auflage, with this new analysis, we must remember that the previous analyses were made some years ago. In the last few years the processes which have been employed have been so much more exact that these results must be considered far more trustworthy than those made at an earlier date. It is not remarkable, therefore, that distinct differences should be found between this new analysis and the analyses which have hitherto been made, and presumably this last analysis is the correct one. It has been made with the greatest care, and by means of the most improved technique, by two eminently competent and well-known chemists, who in their work have acted as controls on each other. In this way great precision has been attained.

The residue obtained from the evaporation of about six quarts of woman's milk was extracted with naphtha to remove the fat, and then ignited at a very low temperature so as to prevent the volatilization of the chlorides. The ignition was accomplished by placing the residue from the naphtha extraction in a platinum dish which was supported on a platinum coil inside of a larger platinum dish, the latter being heated with a free flame. Even at this low temperature a partial change in the composition of the ash took place, the sulphates being reduced to sulphites, but not to sulphides, as the ash on being carefully tested showed that sulphides were not present. All the carbonates of calcium and all the carbonates of magnesium were reduced to oxides. The ash also contained seven-tenths of one per cent. of unconsumed carbon.

In woman's milk of course there would be no free carbon. All the calcium that did not exist as phosphate would be in the form of sulphate and carbonate, not of sulphite and oxide as found in the ignited ash. The magnesium would exist as carbonate, not as oxide, and the potassium as sulphate, carbonate, or chloride. No sulphite of potassium would be present.

The chief differences between this new analysis and all previous ones are as follows :

- (1) The phosphoric acid is less than half as much as previously reported.
- (2) The magnesium is also less than half as much.
- (3) Silica and alumina are present. They have not been returned in any previous analysis.

Assuming the truth of the statement that the constituents of the mineral elements of human milk are subject to great fluctuation according to age and other causes, it is right to assume that the mineral matter examined by Kinnicutt and Harrington, being the product of a large number of women, is a fair average specimen.

From what I have already said you will understand that although chemical analyses enable us to work more intelligently, yet the conclusions which we can draw from them are far from being precise, owing to the variations which may occur and to the insufficient number of reliable analyses which have so far been made. We should therefore be extremely guarded in drawing conclusions, for the present merely looking upon these analytical results as important. It is very desirable that when reliable analyses are made they should be published, and thus as our information increases we shall be enabled to arrive at results which will greatly aid us in regulating the period of lactation.

VARIATIONS IN MILK.—We are led to expect that we shall find that where the milk is poor and does not agree with the infant there is an excess of proteids and a diminution of fat beyond what we have so far been able to determine as the normal average percentages of these two elements. Again, where a variation takes place in the milk it is more likely to be found in the fat and proteids, as already stated, than in the sugar or the ash. I should also advise you to have a number of analyses made, on different days and at different times, in order that the error of an especial or temporary variation may be corrected. The importance of the assistance which can be gained from these analyses is, in my opinion, very great, and many more analyses should be made than we are now in the habit of deeming necessary. The question of expense should not for a moment be considered by those who can afford to have analyses made, for not only will real benefit come to their own children through money spent in this way, but these analyses, when published and collated, will prove of great value for the proper regulation of the feeding of infants in all classes of society. An error for which we must always allow may interfere with the true analysis of the milk which the infant has actually received in its stomach at the end of the nursing, and is one which must necessarily invalidate the information which we receive from our analysis. I have already referred to this subject in speaking of the changes which arise from slight causes and influence the special specimen which is being analyzed. Thus, we should recognize that the milk varies considerably in its percentage of fat and total solids in the different periods of a nursing, and that the composition of the milk which the infant has in its stomach may differ very widely from the composition of a specimen taken directly before or after the nursing. Harrington's analyses of the three periods of a milking will illustrate the meaning of what has just been said, and although they were made from the milk of a cow, yet, knowing the closely analogous conditions existing in human and in animal milk, we shall find them equally valuable

in explaining the corresponding changes met with in woman's milk. They are represented in this table (Table 36) :

TABLE 36.

	Fat.	Total Solids.	Water.	Ash.
"Fore-milk" . . . . .	3.88	13.34	86.66	0.85
"Middle milk" . . . . .	6.74	15.40	84.60	0.31
"Strippings" . . . . .	8.12	17.13	82.87	0.82

The analyses of J. Reiset and Peligot are also of considerable interest as showing not only the increase of solids at the end of a milking, but also that this increase is mostly of the fat, and to a lesser degree of the proteids, and, as I have already stated, that a short interval of nursing increases the solid constituents in proportion to the water, the reverse of this being true where the intervals are long.

Heidenhain explains this physiological phenomenon by saying that his investigations point towards the fact that during the pauses between the milkings the cells of the glands are growing. During this time a proportionately small amount of solids and a proportionately large amount of water are secreted, while the irritation of milking causes increased activity of the milk-cells, with a corresponding increase in the solid secretion and a lessening of the water. Peligot's table, giving the analysis of an ass's milk in three different portions, shows the relations of the solids both to the water and to one another :

TABLE 37. (Peligot.)

<i>Ass's Milk.</i>			
	1st Portion.	2d Portion.	3d Portion.
Butter . . . . .	0.96	1.02	1.52
Milk-sugar . . . . .	6.50	6.48	6.50
Casein . . . . .	1.76	1.95	2.95

His second table shows the changes of proportion according to the intervals of milking :

TABLE 38. (Peligot.)

<i>Ass's Milk.</i>			
	Milking Intervals.		
	1½ hours.	6 hours.	24 hours.
Butter . . . . .	1.55	1.40	1.23
Sugar . . . . .	6.65	6.40	6.33
Casein . . . . .	3.46	1.55	1.01

The next table is also interesting, and should be recorded :

TABLE 39. (Reiset.)

<i>Cow's Milk.</i>		Percentage of Solids at	
Last Time since Milking.		Beginning.	End.
12 hours . . . . .		9.33	16.04
6 " . . . . .		12.80	16.06
2½ " . . . . .		12.84	13.08





TABLE 41.—*Continued.*

	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Fat . . . . .	3.76	3.30	3.16	2.96	2.36	2.09	2.02
Milk-sugar . . .	6.95	7.30	7.20	5.78	7.10	6.70	6.55
Proteids . . . .	2.04	3.07	1.65	1.91	2.20	1.38	2.12
Ash . . . . .	0.14	0.12	0.21	0.12	0.16	0.15	0.15
Total solids . . .	12.89	13.79	12.22	10.77	11.82	10.32	10.84
Water . . . . .	87.11	86.21	87.78	89.23	88.18	89.68	89.16
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

All these specimens of milk were obtained from healthy mothers, and in every case the infant was thriving. In a number of these cases, however, when one of the infants which was doing well on its own mother's milk was fed with one of the other combinations, it soon became sick, and had to be changed back to the one adapted to its digestion. Human milk may, then, be considered to represent not an especial food but a combination of foods, and its fat, sugar, proteids, and ash to represent these different foods. In other words, we find by experience that the digestive capabilities of infants differ, just as do those of adults, and that nature provides a number of varieties of good human milk adapted to the varying idiosyncrasies of infants.

**BACTERIOLOGICAL EXAMINATION.**—Although human milk is usually considered to be sterile, except in some cases in which the woman is diseased, yet Cohn and Neumann have examined the milk of forty-eight healthy women and have found bacteria in forty-three cases. These organisms were mostly represented by the staphylococcus pyogenes albus, with a few of the staphylococcus pyogenes aureus and the streptococcus pyogenes. They found fewer bacteria when the breast had been emptied a short time previously, and more when there had been a stagnation of the milk in the breast. More bacteria were also found in the first few drops than in the last ones, and from their experiments they concluded that the bacteria enter the nipple from without. The conclusions deduced from their experiments, as well as from the experiments of others who have met with similar results, seem to show practically that bacteria can enter the ducts of the nipple and penetrate to a greater or less distance; also that the milk in its course from the gland to the nipple washes out the bacteria, and that we can in this way account for the presence of these organisms in the milk which is first drawn from the breast, and their absence from that which comes later.

Young animals at birth begin to receive their nourishment immediately, and a corresponding increase in their weight takes place from the first day of life. The human infant in like manner should begin with its nursing early, getting what it can from the breast until the full supply of milk has come. In this way it will not be so likely to have a large initial loss of weight to regain, a condition by which it is often handicapped at the very beginning of its career, when there is most danger to be apprehended from a depression of its vitality. Every day, every hour, is of the utmost importance

in the early days of life, and, provided it can be done without detriment to the condition of the mother, the sooner the infant is put to the breast the better it will be. Under exceptionally favorable circumstances, as I have already told you, we see the breast-fed infant steadily gaining in weight during the first year of its life (Lecture IV., page 103). Ordinarily, however, we find this uniform increase in weight, which I have just indicated to you in speaking of the infant at the breast (Case 61, page 160), to be interrupted from time to time by various causes. These may arise during the dental period, in vaccination, from some temporary trouble arising in the breast of the mother, or from a combination of circumstances which may prevent the infant from receiving the proper qualitative elements in its food, or from obtaining a sufficient quantity. This continual increase in weight is of the greatest importance in the first year, as it is the chief index by which we note the progress of nutrition in the infant and the normal condition of the milk. During the first twelve hours of life, and in most cases during the first twenty-four to thirty-six hours, owing to the inability of the mother to supply milk for her infant, scarcely any food is, as a rule, obtained. If during this period the infant is restless and evidently hungry, 5 to 10 c.c. (1 to 2 drachms) of a sugar solution may be given at intervals of two or three hours. This solution should be made by dissolving milk-sugar in sterilized water, and its strength should be from five to six per cent. If the mother's milk is delayed still longer, something additional must be given to the infant, and if the food can be obtained from a milk-laboratory, I should order the following prescription :

## PRESCRIPTION 3.

Fat . . . . .	1.00
Sugar . . . . .	5.00
Proteids . . . . .	0.75

Reaction slightly alkaline.

10 feedings, each 30 c.c. (1 ounce). To be heated for thirty minutes at 75° C. (167° F.).

Where the infant's food has to be prepared at home, these proportions of fat, sugar, and proteids can be obtained, as I shall explain to you later (Lecture X., page 279), in my lecture on the home modification of milk.

The younger the infant the greater the metabolic activity, and hence the greater need of frequent feeding, for food is required not only for repair of waste, but also for the infant's rapid proportionate growth. This, with the increased demand for additional animal heat, makes essential the regulation of the intervals of feeding according to the age.

INTERVALS OF FEEDING.—The intervals constitute a very important part of the management of breast feeding, where, as I have told you, the quantity is regulated by the breast itself. These intervals should be definitely stated to the mother at different times throughout the nursing period, and should be adhered to. I have represented in this table (Table 42, page 182) the intervals which should be recommended. You must, however,



understand that these are only average rules, and that the intervals of feeding should be made to correspond to the stage of development of the individual.

TABLE 42.

*The day feedings are supposed to begin with the 6 A.M. feeding and to end with the 10 P.M. feeding.*

Age.	Intervals.	Number of Feedings in 24 hours.	Number of Night Feedings.
From birth to 4 weeks . .	2 hours . . . . .	10	1
“ 4 to 6 “ . .	2 “ . . . . .	9	1
“ 6 to 8 “ . .	2½ “ . . . . .	8	1
“ 2 to 4 months . .	2½ “ . . . . .	7	0
“ 4 to 10 “ . .	3 “ . . . . .	6	0
“ 10 to 12 “ . .	3 “ . . . . .	5	0

When the milk has begun to be produced in the breast, the infant should be fed once in two hours during the day and once during the night until it is six weeks old. The day feedings are usually reckoned from 6 A.M. to 10 P.M. This interval of two hours should be adhered to, allowing that exceptional circumstances may arise where the physician must judge according to the individual case, until the sixth or eighth week is reached, when the intervals may be made two and one-half hours, and the number of feedings in the twenty-four hours eight. At about the fourth month the intervals can be made three hours, and the number of feedings six. When the infant is two or three months old, the night feeding can be omitted. The number of feedings at ten months may be reduced to five. Allowing the mother to have as many hours of continuous sleep at night as possible is especially important, in order that she may not be exhausted by the lack of that regular and sufficient rest which is of the utmost necessity for the production of a normal milk.

Irregularity in nursing, too frequent nursing, and too prolonged intervals often so disturb the quality of human milk as to transform a perfectly good milk into one entirely unfitted for the infant's powers of digestion. Thus, as I have previously explained to you, too frequent nursing lessens the water and increases the total solids in human milk, making it resemble in a certain way condensed milk; while too prolonged intervals result in such a decrease of the total solids as to render an otherwise good milk too watery and unfit for purposes of nutrition, however well it may be digested. I repeat, then, that the lesson that may be drawn from these facts is that some general rule for the feeding intervals should not only be recommended but enforced. The mother should neither injure her infant's digestion by nursing it too frequently, and thus giving it a too concentrated fluid, nor, by neglecting to feed it often enough, interfere with its nutrition by giving it a food that is too diluted.

REGIMEN OF LACTATION. Diet.—The diet of the nursing mother should not essentially differ from what would be considered to be a healthy one for her at any time. There is no special diet which, under all circum-

stances, is best for all nursing women during the period of their lactation. In the early days of the puerperium there is, as a rule, more danger of overfeeding than of underfeeding the mother. The tendency, in my opinion, is to give too much meat and solid food, with the result that when the secretion of the milk is being established the total solids are increased to a degree beyond the capacity of the still undeveloped digestive function of the infant. I have usually found that infants in the early days and weeks of life thrive better on a milk that shows a high percentage of water in proportion to that of the total solids. A rule which has in my experience become almost an axiom is that the age of the individual infant is in inverse proportion to its powers of absorbing solid food, and in direct proportion to the need of a large amount of water in its food. A light and plentiful diet should therefore be given to the mother while she is confined to her bed. This diet should consist of milk, gruels, soups, vegetables, bread and butter, and after the first week a small amount of meat once during the twenty-four hours. When the mother is able to go out of the house again, and has resumed her usual habits, the quality of the diet can be very much increased, and she can have the usual variety of food represented by meats, vegetables, milk, fruits, and cereals. There are no special kinds of food which are contra-indicated, provided we keep the food within the limits of the ordinary articles which commonly represent a plain but nutritious diet. It is very important for the nursing mother to have her meals at regular intervals, and during the early part of the lactation to take food somewhat more frequently than when she is not nursing. The additional meals, as a rule, should be made up of milk or cocoa. I have not seen the advantage of adding any special beverages, such as beer, malt, or stimulants, to her diet. She should receive as much milk as is compatible with her digestion, and should drink a plentiful supply before retiring at night. I have recommended this wide range of food for the nursing mother with a purpose,—namely, that it seems necessary to counteract many erroneous ideas and false views which are held on this subject. In my experience I have frequently met with mothers who were being deprived of the very articles which would in their special case have tended to aid in the production of good milk for their infants. The food of the nursing woman is without doubt closely connected with that which she provides for her infant. I have already spoken of the possibility of the elimination of various substances by the mammary gland, and we should therefore impress upon mothers the importance of a carefully arranged diet when they are nursing. Certain vegetables, and sometimes fish, will in individual cases affect the milk and cause discomfort to the infant. We must, then, in every case, seek to determine which article of diet may cause disturbance in the special woman's milk secretion, and eliminate that article. We should, however, be very careful not to prohibit this special article of diet from the regimen of a large number of women to whom it might be of benefit rather than of harm, simply because it has affected the milk of a few women. For the average



woman a plain mixed diet, with a moderate excess of fluids and proteids over what she is normally accustomed to, will, as a rule, give the best results.

**Exercise.**—Exercise has so constant an influence on the changes which take place in the daily secretion of the milk, that the mother should be encouraged to be out of bed and to walk about her room as soon after her confinement as is possible without injuring her physical condition. Exercise is so important for promoting the proper elaboration and equilibrium of the milk secretion during the entire period of lactation, that it should always be insisted upon, and regular hours for walking should be as definitely arranged during the day as the hours for eating. The exercise must, however, be in accordance with the strength of the special woman, for fatigue has the same deleterious influence on the production of the milk as has lack of exercise.

**DISTURBED LACTATION.**—The disturbances which are liable to occur in the course of lactation are frequent and varied. They should be studied carefully and recognized at once when they occur, or the continuation of the lactation may not only be interfered with but be prevented entirely. When discussing the significance of the appearance of colostrum corpuscles in human milk (Lecture VII., page 166), I dwelt so fully on the variations which are coincident with this appearance, that I shall now merely refer to them as among the possibilities of a disturbed lactation. When they are found after the first two weeks of life the milk should be looked upon with distrust, and special efforts should be made to discover their cause, and to prevent the dangers which are liable under these circumstances to arise. These dangers may be not only from combinations of the milk elements which are incompatible with the infant's digestion, but also from the disturbances which may arise from the free mammary elimination of foreign material, which I have already referred to.

**Drugs.**—We know that during periods of mammary disturbance there is a much greater possibility, than when the gland is in a normal condition, of the direct transudation from the blood of such inorganic substances as arsenic, antimony, lead, iodide of potash, mercury, and others, taken by the mother. Well-authenticated cases come to our notice from time to time where injury has been done to the nursing infant in this way, and where even death has occurred from the elimination by the breast-milk of certain organic substances, such as colchicum and morphine.

The greatest variety of substances have been found in the milk, but no definite rule as to the amount of this elimination has yet been established, so that our knowledge of the existence of this process is valuable as a prophylactic against harm, rather than as a means of direct benefit to the infant in disease, which latter point I shall not discuss except to call attention to the fact that the medicinal treatment of infantile disease through the breast-milk is exceedingly inexact.

We must also recognize the clinical fact that this elimination may occur at any time during the nursing period in the breasts of women who, so far



as we can ascertain, are in a perfectly healthy condition. Thus, every practitioner has at times doubtless observed the laxative effect on the infant of such drugs as compound liquorice powder given to the mother; and a case has lately come to my notice where an infant vomited for weeks while taking the milk from the breast of its mother, who was unusually well and strong, but who was in the habit of drinking a considerable quantity of porter daily. After the porter was omitted the vomiting ceased at once, and did not return.

These facts warn us that the use of drugs during the period of lactation should be far more limited than at other times. Saline cathartics may not only act unfavorably on the infant through the mammary excretion, but may lessen very decidedly the flow of the milk, and even stop it altogether.

**MENSTRUATION.**—We must next consider the question of the variation in the milk which takes place from natural causes, such as the return of menstruation. Does such a return necessarily contra-indicate the continuation of nursing? As in all questions of this kind, we cannot adopt and follow an inflexible rule, but must be guided by what seems best for the individual case. Infants are at times affected so seriously by the alteration in the constituents of the milk which occurs once in four weeks that their nutrition is markedly interfered with, and a change to a more stable food is indicated. Again, the only disturbance which may arise is a temporary and slight digestive attack for a day or two, which apparently does not materially affect the infant, and makes us hesitate to run the risk of depriving it of a food on which it thrives during twenty-six days out of twenty-eight. We must also not be too hasty in concluding from the bad symptoms in the infant that we should at once withdraw it permanently from the breast, for the catamenia may appear once, and then not again for a number of months, the infant's powers of digestion in the mean time becoming so much more fully developed that they are unaffected by the milk of the catamenial period. Even where the catamenia recur regularly, the disturbance which may have been great at one period may for many reasons fail to recur at the next; so that the question is reduced to whether the composition of the milk shows a recovery of the equilibrium of its constituents within a few days, or remains affected to such a degree as to endanger the integrity of the infant's nutrition.

My own experience is in favor of allowing the infant to continue with the breast, unless it is decidedly contra-indicated by circumstances such as have just been mentioned.

I have seldom met cases which could not without permanent injury be tided over the small amount of temporary digestive disturbance which may arise. Within a few days I have seen a case where the return of the catamenia produced no effect whatever on the infant; and this is only an instance of what in all probability often occurs where mother and infant are at the time in an otherwise normal condition. There have, as yet, been too few analyses made during the catamenial period to justify us in drawing any definite conclusions as to the chemical status of the question; but the proba-

bility is that the milk will be found to be deficient in fat and to have its proteids increased, following the general rule of disturbed mammary secretion, and that consequently it is in a condition to interfere temporarily with both digestion and nutrition.

PREGNANCY.—A much more serious question arises when the nursing mother becomes pregnant; for here the almost universal clinical experience is that the infant, for various reasons, cannot continue to be fed by its mother, it being unusual for a woman to have sufficient vitality to nourish properly her living child and growing foetus. The danger of reflex miscarriage from the continual irritation of the mammary gland by nursing I personally have had no experience with, but this is mentioned as one of the dangers contra-indicating the continuation of nursing by a pregnant woman. We must, however, here also not judge hastily, but take all the circumstances of the case into consideration before deciding on a measure of such vital importance to both child and foetus. If the mother remains strong and vigorous, and the analysis of her milk shows no deterioration, while the infant is a delicate one just beginning to thrive on its rightful supply of natural food, or if it is during a hot period of the year, and especially where a wet-nurse or feeding from a milk-laboratory cannot be employed, it will often be wisest to take some risk and continue the nursing for a certain time, perhaps six or eight weeks, and then, according to circumstances, gradually to substitute another food. Almost every case will differ in the questions to be decided, and must be judged on its own indications and contra-indications, always, however, recognizing the accepted rule that lactation and pregnancy are usually incompatible.

The nursing mother is inclined to believe that if she feels well and strong her milk must be good for her infant under all circumstances. She therefore frequently transgresses the rules which are necessary for keeping her milk in equilibrium, and she should be made to understand that sometimes abnormal variations are liable to arise, however good her general health may be. She is simply fulfilling a task demanded by nature from those who bear children, and her duty, when once she has undertaken to nurse, is to prevent as much as possible these variations by regulating her life to a normal standard and avoiding excitement. Both of these requisites of a normal lactation come within the province of the physician to explain as he would any other branch of rational medicine. He should impress upon her that emotional mothers do not make good nurses, and that the physiological influence of the emotions on the nervous system, with its resulting changes in the mammary secretion, has necessarily a much wider range in women who are subjected to the customs and vicissitudes of modern life than it has in those who live in a more natural way.

Having shown you in Table 41 the great variations which occur in the percentages of the elements of human milk, I will now endeavor to explain to you by means of another table (Table 43) the percentages and combinations which you will be likely to meet with in abnormal milk.



TABLE 43.

*Showing typical analyses of a normal, a poor, an over-rich, and a bad human breast-milk.*

	Normal Milk. (Healthy life as to exercise and food.)	Poor Milk. (Starvation.)	Over-rich Milk. (Rich feeding; lack of exer- cise.)	Bad Milk. (Pregnancy, Disease, etc.)
Fat . . . . .	4	1.10	5.10	0.80
Sugar . . . . .	7	4.00	7.50	5.00
Proteids . . . . .	1.50	2.50	3.50	4.50
Ash . . . . .	0.15	0.09	0.20	0.09
Total solids . . . . .	12.65	7.69	16.30	10.39
Water . . . . .	87.35	92.31	83.70	89.61
	100.00	100.00	100.00	100.00

The terms poor and bad milk are merely relative, and in common use do not have a definite meaning. I shall, therefore, explain the distinction which I make between them. I have adopted the terms for the purpose of simplicity and to distinguish a milk which can be restored easily to a normal condition from one where the difficulty of such restoration is very great. By a poor milk I mean one which represents a condition of lack of nourishment or starvation in the mother, but one which can easily be changed by the proper feeding of the mother. In this case the normal mechanism of the mammary gland has not been interfered with. By a bad milk I mean one which represents a profound disturbance of the mechanism of the mammary gland produced by many causes, disease, pregnancy, and especially extreme nervous conditions in the mother, and one which cannot be easily changed to a good milk.

I shall now show you a table (Table 44) in which I have condensed the many means which you will have to make use of in managing the most difficult question which we meet with in the treatment of infants.

TABLE 44.

*General Principles for Guidance in managing a Disturbed Lactation.*

To increase the total quantity . . . . .	Increase proportionately the liquids in the mother's diet, and encourage her to believe that she will be enabled to nurse her infant.
To decrease the total quantity . . . . . (Rarely necessary.)	Decrease proportionately the liquids in the mother's diet.
To increase the total solids . . . . .	Shorten the nursing intervals; decrease the exercise; decrease the proportion of liquids in the mother's diet
To decrease the total solids . . . . .	Prolong the nursing intervals; increase the exercise; increase the proportion of liquids in the mother's diet.
To increase the fat . . . . .	Increase the proportion of meat in the diet.
To decrease the fat . . . . .	Decrease the proportion of meat in the diet.
To increase the proteids . . . . . (Very rarely indicated.)	Decrease the exercise.
To decrease the proteids . . . . .	Increase the exercise up to the limit of fatigue for the individual.



In attempting to formulate these rules I must warn you that I am dealing with a subject of which very little is known definitely. I can, therefore, at present only state my experience in a large number of cases, and give you some general idea of how you are to recognize whether you are dealing with a bad or poor milk rather than with a normal variation of a good milk. This knowledge, however, of the variations which take place in human milk is of the utmost clinical importance during the period of lactation, for it is the only means by which we can decide definitely and intelligently many vital questions in this period.

**THE MANAGEMENT OF DISTURBED LACTATION.**—Instances have continually been brought to my notice where infants have been allowed either to continue with their mothers' milk when they were not thriving on it, simply because it was mother's milk, or, on the other hand, have been weaned from their mothers for what would evidently have been insufficient reasons had the case been thoroughly understood. In both instances a proper knowledge of what can be done with human milk—that is, with the management of its different constituents by increasing or decreasing their relative proportions—would have been of benefit to both mother and child, and in some cases would have saved the life of the latter. This lack of knowledge, or, I should say, lack of adaptation of the knowledge which we possess of this branch of medicine, is, to say the least, reprehensible, and in other branches of our art, which are more intelligently and carefully studied, would be deemed inexcusable. Physicians are continually stating to their patients that human breast-milk is the best food for infants, and at the same time are content to ignore the very principles which would make their statements true. We should understand that when we speak of the superiority of breast-milk as a food, we mean good average breast-milk and for the average infant.

In all these cases of disturbed lactation we must first determine whether the symptoms in the infant are really caused by a disturbance of the milk-supply. We ascertain first whether the supply of milk is sufficient in quantity by the methods which I have already described to you. We then investigate the quality of the milk. A chemical analysis shows us whether the percentages of the different elements are (1) normal or (2) abnormal. If we find them to be normal, we know that it is not the milk which is disturbing the infant, and we must seek for the cause of the disturbance in other sources beyond the breast. If we find the percentages to differ decidedly from those of average human milk, we must determine whether it is the variation from the normal average percentage which is producing the trouble, or whether these percentages are really well adapted to the infant and the cause of the trouble is to be looked for elsewhere. This can be done only by changing the different percentages and watching the result. If we find them abnormal, we can usually determine whether it is one or several of the elements which are producing unfavorable symptoms, and we should endeavor by our treatment to change the percentages of these ele-

ments so as to correspond first to the normal average percentages, and then, if this is not sufficient, to reduce them to lower percentages than the average until the infant's digestive functions have recovered their equilibrium. We must not forget in applying these principles that the cause of the disturbance of the milk exists in some abnormal condition of the mother, whether physiological or pathological, and that we must first remove this cause or we shall fail to regulate the milk.

A sedentary life, with abundance of rich, mixed food, provided the woman has a strong, healthy digestion, appears to increase the total solids and to decrease the water. This increase is almost always in the fats and proteids rather than in the sugar and ash; in fact, the marked variations in human milk are almost always shown in the fat and proteids, and hence our attention must almost invariably be directed to correcting these elements. This is fortunate, as we know of no special treatment, except on very general principles, by which we can alter the proportion of sugar or salts to the other constituents. A meat, or rather a nitrogenous, diet in the woman increases the fat in her milk. Our physiological knowledge also indicates that much fat eaten by the woman tends rather to lessen the fat in her milk. Hence to increase the proportion of fat in a woman's milk we should give much meat and only a moderate amount of fat. The proteids are more difficult to deal with. They have a tendency to increase in very bad and in very rich milk. The problem which we have to solve is almost always how to decrease them, no matter what the milk is. Our knowledge, unfortunately, concerning a sure means of reducing the proteids is very limited. Practically, however, I have found that where the woman is in good health it is physical exercise which we must insist upon, preferably walking in the open air and within the limits of fatigue. A walk of from one to two miles twice daily I have found to be about what the average healthy woman in New England needs to reduce the percentage of the proteids in her milk; but the amount of exercise must be carefully regulated according to the physical capabilities of the individual.

Bearing in mind these simple rules, and having determined, by means of an analysis or analyses, the cause of the special disturbance, you will be able to regulate the nursing period in cases where a lack of this knowledge would often necessitate weaning. You may in this way also avoid serious harm to the infant.

I shall next call your attention to these illustrative tables, which still further explain the rules I have just given you. I shall presently describe in detail some of these cases and discuss their analyses, but this repetition I deem advisable, as the subject is both important and difficult. For the purpose of still greater clearness I have in each of these tables first recorded the analysis of a normal milk, and have then, in parallel columns, shown the abnormal percentages and the changes produced in them by the management of the mammæ.

TABLE 45.

(Human Milk.)

*Showing the influence of a luxurious life on a poorly-fed but healthy wet-nurse.*

	I.	II.	III.	IV.
	Normal.	Two days before change of food.	Rich food and but little exercise for a month.	Food and exercise regulated.
Fat . . . . .	4.00	0.72	5.44	5.50
Sugar . . . . .	7.00	6.75	6.25	6.60
Proteids . . . . .	1.50	2.53	4.61	2.90
Ash . . . . .	0.15	0.22	0.20	0.14
Total solids . . . . .	12.65	10.22	16.50	15.14
Water . . . . .	87.35	89.78	83.50	84.86
	100.00	100.00	100.00	100.00

TABLE 46.

(Human Milk.)

*Showing a bad milk and one which it was impossible to manage on account of the continual recurrence of the same cause, uncontrolled emotions.*

	Normal.	Emotions causing disturbance in infant's digestion.
Fat . . . . .	4.00	0.62
Sugar . . . . .	7.00	5.80
Proteids . . . . .	1.50	4.21
Ash . . . . .	0.15	0.20
Total solids . . . . .	12.65	10.83
Water . . . . .	87.35	89.17
	100.00	100.00

TABLE 47.

(Human Milk.)

*Showing a milk possible to manage, because the mother, though excitable, was able and willing to control her emotions.*

	Normal.	Infant doing badly. Colic. Mother before treatment.	Infant doing well. Mother after treatment.	Wet-nurse provided but not used.
Fat . . . . .	4.00	1.62	3.20	3.04
Sugar . . . . .	7.00	6.10	6.40	6.60
Proteids . . . . .	1.50	3.54	2.52	2.32
Ash . . . . .	0.15	0.17	0.18	0.12
Total solids . . . . .	12.65	11.43	12.30	12.08
Water . . . . .	87.35	88.57	87.70	87.92
	100.00	100.00	100.00	100.00

In the above case the mother was very nervous and wished to nurse her infant, but thought that she could not, as she had been discouraged by her nurse and physician.

She was then told that she could nurse in a week, if in the mean time she took proper food and exercise and withdrew the infant from the breast. This she did, and had her breasts regularly pumped, with good results.



TABLE 48.  
(Human Milk.)

*Showing the effect of the catamenia on human milk.*

	Normal.	Catamenia, Second Day.	Seven Days after Catamenia.	Forty Days after Catamenia.
Fat . . . . .	4.00	1.37	2.02	2.74
Sugar . . . . .	7.00	6.10	6.55	6.35
Proteids . . . . .	1.50	2.78	2.12	0.98
Ash . . . . .	0.15	0.15	0.15	0.14
Total solids . . .	12.65	10.40	10.84	10.21
Water . . . . .	87.35	89.60	89.16	89.79
	100.00	100.00	100.00	100.00

TABLE 49.  
(Human Milk.)

*Showing a milk in which the proteids, which were disturbing the infant, could not be reduced until the mother was made to walk comfortably, and thus without fatigue.*

	Normal.	Infant with colic and vomiting. Mother taking no exercise and very rich food.	Infant as before. Mother walking two miles daily, but having blis- ters from French shoes.	Infant doing well. Mother walking two miles. Easy shoes, no blis- ters.
Fat . . . . .	4.00	3.05	0.65	3.34
Sugar . . . . .	7.00	6.10	5.25	6.30
Proteids . . . . .	1.50	3.89	3.82	2.61
Ash . . . . .	0.15	0.16	0.18	0.16
Total solids . . .	12.65	13.20	9.90	12.41
Water . . . . .	87.35	86.80	90.10	87.59
	100.00	100.00	100.00	100.00

TABLE 50.  
(Human Milk.)

*Showing how a milk can be managed while the nursing is continued.*

	Normal.	Infant two weeks old, with serious general nervous symptoms and pain. Mother eating much meat and taking no exercise.	Mother walking and eating less meat. Infant entirely well.	Infant four months old, with pain and diar- rhœa. Mother not walking so much.	Infant doing well. Mother walking two miles daily. Milk diluted one-fifth.
Fat . . . . .	4.00	3.44	2.09	3.98	3.19
Sugar . . . . .	7.00	5.60	6.70	7.00	5.60
Proteids . . . . .	1.50	3.96	1.38	2.22	1.78
Ash . . . . .	0.15	0.20	0.15	0.19	0.16
Total solids . . .	12.65	13.20	10.32	13.39	10.73
Water . . . . .	87.35	86.80	89.68	86.61	89.27
	100.00	100.00	100.00	100.00	100.00

As is seen from the analyses in Table 50, the infant did not do well until the mother began to exercise, and at four months it was again affected by apparently the high percentage of the proteids. The infant was considerably under the weight corresponding to that of the average infant of

four months. It was found to nurse twenty-five minutes at a time, and by calculation from its weight before and after nursing, it was found to take from 80 to 120 c.c. (20 to 30 drachms). This amount being larger than the probable size of its stomach demanded, the time of the nursing was reduced to twenty minutes, and 20 c.c. (5 drachms) of sterilized water were given in the middle of the nursing, thus changing the percentages in the milk to the figures which are represented in the last column. This calculation is on the basis of 100 c.c. (25 drachms) to each nursing.

So long as this method of feeding was adhered to, the infant did well. It was evidently a case where the infant could not digest over two per cent. of proteids.

TABLE 51.  
(Human Milk.)

*Showing that even for a long interval the breasts may be pumped and the result be a successful nursing.*

	Normal.	Infant showing nervous symptoms and much uric acid. Mother taking no exercise and much rich food.	Infant showing no uric acid and thriving. Mother walking two miles and not eating much meat.
Fat . . . . .	4.00	5.71	2.67
Sugar . . . . .	7.00	4.00	6.60
Proteids . . . . .	1.50	4.29	3.18
Ash . . . . .	0.15	0.19	0.17
Total solids . . . . .	12.65	14.19	12.62
Water . . . . .	87.35	85.81	87.38
	100.00	100.00	100.00

In this case the infant was withdrawn from the breast temporarily, and the breasts pumped for twenty-seven days.

When the analysis presented the figures seen in the last column, the milk was treated by diluting it, as in the previous case, and the infant was put back to the breast.

TABLE 52.  
(Human Milk.)

*Showing the value of retaining the breast-milk by managing even an unpromising case.*

	Normal.	Infant with colic and failing. Mother no exercise, nursing irregularly, and improper sweet food. Nervous, worried condition.	Infant put on bottle. Breasts pumped every four hours. Moderate exercise,—one milc. Full regular diet. Tranquil.	Exercise increased to two miles. Small amount of meat.	Eating much meat. Exercise the same.
Fat . . . . .	4.00	0.34	3.24	2.79	4.84
Sugar . . . . .	7.00	5.40	5.45	5.05	6.00
Proteids . . . . .	1.50	3.61	3.95	3.66	3.42
Ash . . . . .	0.15	0.18	0.16	0.20	0 17
Total solids . . . . .	12.65	9.53	12.80	11.70	14 43
Water . . . . .	87.35	90.47	87.20	88.30	85.57
	100.00	100.00	100.00	100.00	100.00

The above represents a bad milk from the failure of the healthy mother to conform to the rules of lactation. This bad milk, represented in the second column, had to be made into a rich milk by regular feeding before any attempt could be made to alter the ratio of the constituents. The proteids were then reduced somewhat by exercise, and, after the breasts had been pumped for two weeks, the analysis showed the percentages as represented in the last column. The milk was then diluted with sterilized water by the same method as was explained in Table 50, and the infant was put to the breast and did well; in fact, was carried through an attack of retro-pharyngeal abscess with this breast-milk.

If you have carefully studied these tables (Tables 43, 45, 46, 47, 48, 49, 50, 51, 52) and the principles (Table 44) on which they are based, you can appreciate the importance of the interesting illustrative cases which I am about to describe to you. I have selected them from a large number of my patients because they represented so well the value of a knowledge which aids us in the management of human milk during periods of disturbed lactation.

The decrease in the total quantity of the milk is of ordinary occurrence at any time during lactation, but it is most common among civilized races at about the eighth to the tenth month. When it occurs early in the lactation it is very disheartening to the mother if she is desirous of continuing her nursing. She becomes fearful that the flow of milk may stop altogether, and the nervous influence thus brought to bear on the mammary gland tends to increase the disturbance. We should therefore encourage her to believe that the milk will return. I have just succeeded in restoring the full quantity of milk in the mammary glands of a multipara (Case 63) who was very anxious to nurse her infant, which was three weeks old and had been digesting her milk, but had never nursed vigorously, and was not gaining. The mother was much discouraged because her milk lessened in quantity so early in the lactation, and she was convinced that it would not return. She had been taking, without my knowledge, a disproportionately small amount of fluid in her diet. There was an element in this case which the intelligent nurse brought to my notice,—namely, that the infant (Case 64) was not vigorous, and when put to the breast sucked feebly and called upon the gland for very little milk. Reacting to this lack of stimulus, the gland, although in a normal condition, secreted only the small amount demanded by the infant, and the milk lessened day by day. Treatment was instituted on the supposition that the mammary gland is practically self-regulating as to the amount of food which it will elaborate at a given nursing. If it happens to be called upon to nourish twins, it will increase the amount of its supply. If the infant which is put to it has a small gastric capacity, it will produce the amount needed for that capacity. I assured the mother that the milk would return, and I treated directly the mammary gland itself. An increase was made in the amount of liquid in the mother's diet, and the breasts were, after each nursing, pumped gently, skilfully, and thoroughly. The breast-pump supplemented the feeble action of the infant, and when



more work was required of the gland it began to produce more milk. The increase in the liquid diet supplied the gland with materials to work with, and its mechanism ceased to be disturbed by the nervous influence emanating from the mother. She became cheerful when she found the milk returning, while the infant, now that the milk could be procured more easily, demanded more, sucked more vigorously, and thus satisfied the sensitive mechanism of the mammæ.

The next case (Case 65) points to the possibility of our being at times too hasty in the decision to deprive an infant of its mother's milk.

The mother (see Table 47, page 190), a rather delicate primipara, twenty-five years of age, was delivered of a boy seven pounds in weight. Within four hours puerperal convulsions set in, from which she recovered, but was left with albuminuria 0.25 per cent. and casts. The latter disappeared in a few days, but the albumin, although somewhat diminished, continued; and the patient, naturally of a calm disposition, was in a highly nervous condition, fearing that she could not nurse her infant, but decidedly opposed to having a wet-nurse. The milk appeared in considerable quantity on the fifth day, but the infant did not thrive, and, although it gained somewhat in weight, was very fretful, slept very little, and looked ill, so that the attending physician became alarmed, and after treating it for its dyspepsia without much success until it was five weeks old, and finding that there was still about 0.25 per cent. of albumin in the mother's urine, decided with me that the breast-milk should be withheld until we could determine the cause of the trouble, and an analysis (Analysis 9) was accordingly made, with the following result:

ANALYSIS 9.

Fat . . . . .	1.62
Sugar . . . . .	6.10
Proteids . . . . .	3.54
Ash . . . . .	0.17
Total solids . . . . .	11.43
Water . . . . .	88.57
	<hr/> 100.00

This analysis suggesting the probability that the large amount of proteids was causing the disturbance of digestion, and that the small amount of fat was not sufficient for nutrition, the attending physician was very anxious to procure a wet-nurse; but while we were endeavoring to get a proper one, we decided to empty the mother's breasts with the breast-pump every day, thus relieving her from the worry of attempting to nurse her infant and seeing it fail to gain. She also obtained in this way undisturbed nights and a great deal of out-door life. The infant was in the mean time placed on a substitute food, which was digested very well, and, as it ceased to cry, the mother's mind became tranquil, and the albumin in her urine in a few days was reduced to a trace. The treatment was carried out for a week, the milk continuing to flow freely, and an analysis (Analysis 10) was then made of the mother's milk and also of that of a healthy wet-nurse (Analysis 11) whose infant was thriving on its mother's milk.

ANALYSIS 10.

ANALYSIS 11.

	Mother.	Wet-Nurse.
Fat . . . . .	3.20	3.04
Sugar . . . . .	6.40	6.60
Proteids . . . . .	2.52	2.32
Ash . . . . .	0.18	0.12
Total solids . . . . .	12.30	12.08
Water . . . . .	87.70	87.92
	<hr/> 100.00	<hr/> 100.00

The two milks being equally good, it was decided to allow the infant to begin to take one nursing daily from its mother, although the proteids were still about one per cent. higher than the infant seemed likely to digest; it was given to its mother, nursed well, seemed satisfied, digested its meal without trouble, and at six months is still being nursed and is thriving.

The next case (Case 66) which I shall describe to you illustrates the principle that too frequent nursing lessens the water and increases the total solids in human milk, making it resemble in a certain way condensed milk. It also illustrates what I have stated concerning the two important questions to be considered in the management of a normal lactation,—namely, that the digestion as well as the nutrition must be regarded. This case is one of the numerous instances of the same kind which have come to my notice, and also emphasizes the fact that infants are often weaned from the breast where there is not the slightest necessity for it.

The mother, a healthy primipara about twenty-two years old, had nursed her infant for six weeks, during which time the infant was fretful, suffered much from colic, and never seemed satisfied. There was, however, a continual gain in weight, although the faecal discharges showed evidences of the food not being properly digested and were numerous and watery. By advice of the attending physician the infant was weaned. The mother came to me for advice in regard to placing her infant on a substitute food. On inquiry I found that this infant had been nursed almost continuously night and day, with intervals usually of only one hour, and it was evident that the frequent nursings had resulted in producing a concentrated milk which the infant's gastro-enteric tract was rebelling against and was not digesting, although sufficient food was being absorbed to prevent up to this time any interference with the general nutrition. This infant, then six weeks of age, was deprived of its supply of good human milk in the middle of the summer simply because the important matter of changing the intervals had not been thought of as a means of improving the milk and relieving the pain and apparent hunger. There seems to be no doubt that if the milk in this case had been properly managed it would have agreed perfectly with the infant. I would also add in connection with this case that where the digestion is not carried on properly the nutrition must soon suffer, and it is only in the early weeks of a disturbed digestion that, as a rule, we find the nutrition to be unimpaired.

The next case (Case 67) is one of a multipara who was under my care at the City Hospital, and who up to the time of her entrance had been nursing her infant, which was thriving. This patient stated that her milk had always been abundant and of good color up to the time when she was separated from her infant, which was twelve hours previously, as she had to be away from home for that time. At the end of twelve hours the breast was found to be so distended that the breast-pump had to be applied. The milk was drawn with great ease, almost flowing of itself, and in considerable quantity, but it no longer resembled the milk of the previous nursings which had been at the proper intervals. On the contrary, it was clear, with very little color, the total solids were reduced to a minimum, and it no longer would have nourished the infant.

The treatment of this case was of course to pump the breasts every three hours until the infant could again be nursed.

As an illustration of the harm which may come to an infant from the percentage of fat in its mother's milk being too high, and also of the means to employ either to increase or to decrease the fat in breast-milk, this case (Case 68) will be of interest. The mother was a healthy primipara. She had plenty of milk, but the infant suffered from colic and had very frequent watery dejections. Finding that she was eating a great deal of meat three

times daily and not taking much exercise, I naturally supposed from the symptoms of the infant and the diet of the mother that an over-percentage of fat was one of the elements which were disturbing the lactation, and that a high percentage of proteids would also be found. The analysis (Analysis 12) proved my supposition to be correct:

ANALYSIS 12.

*Primipara.—Healthy; eating much meat; not taking much exercise.*

Fat . . . . .	4.96
Sugar . . . . .	6.60
Proteids . . . . .	3.29
Ash . . . . .	0.17

I therefore decided to reduce the meat to a minimum, which was done, and three days later an analysis gave the following figures:

ANALYSIS 13.

*Eating little meat.*

Fat . . . . .	1.73
Sugar . . . . .	5.70
Proteids . . . . .	3.74
Ash . . . . .	0.13

The milk was found to be lessening in quantity. The infant's dejections were less numerous and had more consistency; but it was not gaining, and continued to have pain. In fact, the analysis showed a poor milk, or even a bad one, as represented by the usual combination of a low percentage of fat and a high percentage of proteids. The woman was consequently made to eat a moderate amount of meat, and to exercise more, and three or four days later the analysis showed an improvement in the fat:

ANALYSIS 14.

*Eating moderate amount of meat; taking more exercise.*

Fat . . . . .	2.42
Sugar . . . . .	5.50
Proteids . . . . .	3.55
Ash . . . . .	0.15

The infant now began to gain in weight, but continued to have colic, as was expected from the high percentage of proteids. The exercise was still further increased, and a later analysis showed a decided lessening of the proteids, as is seen in this analysis (Analysis 15):

ANALYSIS 15.

*Exercise still further increased.*

Fat . . . . .	2.35
Sugar . . . . .	6.25
Proteids . . . . .	2.69
Ash . . . . .	0.15



The infant began to have regular movements, of good consistency, and no longer had pain; it also gained regularly in weight, and, as you see, looks well and strong. The mother has regulated her diet, exercise, and sleep in accordance with the requirements of her infant, and her milk has again become abundant.

We shall, of course, often fail in our attempts to manage the percentage of fat in this way, but this case illustrates exactly the changes which it is usually necessary to produce in order to alter a high fat percentage. The proteids also being high, I had an over-rich milk to deal with; taking away the fat-producing element reduced the fat to a low percentage; exercise reduced the high percentage of proteids, and a combination of sufficient meat and exercise finally produced a milk which could be digested.

This next case (Case 69) is an interesting one, as it illustrates a number of points in the management of lactation. A high percentage of the proteids was creating the disturbance in the infant, and it was their final reduction through treatment that permitted the lactation to go on.

The mother, a remarkably healthy and vigorous multipara, living in the country, had a plentiful supply of milk. Her diet consisted mostly of vegetables, and she did not take much exercise. The infant was not thriving, having had continued attacks of colic, with frequent vomiting, and it did not gain in weight. The analysis (Analysis 16) showed a bad milk, which was contrary to what we should usually expect to find in the milk of a mother who was in such perfect health as this one was.

## ANALYSIS 16.

Fat . . . . .	0.52
Sugar . . . . .	6.80
Proteids . . . . .	2.48
Ash . . . . .	0.15
Total solids . . . . .	9.95
Water . . . . .	90.05
	<hr/> 100.00

The mother was instructed to eat meat and to walk two miles every day. One month later, as the infant had not improved, another analysis was made (Analysis 17), which showed that the milk was in a worse rather than a better condition.

## ANALYSIS 17.

Fat . . . . .	0.45
Sugar . . . . .	6.15
Proteids . . . . .	2.47
Ash . . . . .	0.16
Total solids . . . . .	9.23
Water . . . . .	90.77
	<hr/> 100.00

I found that the mother had eaten meat but once a day, and in small quantity; also that she had not walked much. I then insisted on her eating meat three times a day, and walking three miles. This she did for two weeks, when the infant was found to have gained slightly in weight, but to still have colic and vomiting. Another analysis (Analysis 18) showed an increase in the fat.

ANALYSIS 18.

Fat . . . . .	1.53
Sugar . . . . .	6.68
Proteids . . . . .	2.48
Ash . . . . .	0.16
Total solids . . . . .	10.85
Water . . . . .	89.15
	<u>100.00</u>

During the next two months the walking was continued and the meat increased in quantity. The infant continued to vomit and have colic until the mother was made to ride on horseback every day, when the pain ceased, and from that time the infant gained steadily in weight, and was well and strong during the rest of the lactation. An analysis (Analysis 19) made two and one-half months after this procedure showed that at last the proteids had been reduced to come within the limits of the infant's digestion, and that the fat, although still having a low percentage, had been increased sufficiently for the infant's nutrition. Thus a bad milk was finally changed to a good one. This infant evidently could not digest a percentage of proteids approaching 2, but fortunately could be nourished on a low percentage of fat.

ANALYSIS 19.

Fat . . . . .	2.01
Sugar . . . . .	6.90
Proteids . . . . .	1.54
Ash . . . . .	0.17
Total solids . . . . .	10.62
Water . . . . .	89.38
	<u>100.00</u>

In the next case (Case 70) I had a poor milk to deal with. The infant was four months old. It was perfectly well and was digesting well, but had not gained for three weeks. The mother was producing from her breasts a sufficient quantity of milk, but the analysis (Analysis 20), as you see, shows that this milk had to be modified within the breast by a regulation of the diet of the mother :

ANALYSIS 20.

Fat . . . . .	1.29
Sugar . . . . .	6.05
Proteids . . . . .	2.93
Ash . . . . .	0.12
Total solids . . . . .	10.39
Water . . . . .	89.61
	<u>100.00</u>

She was consequently made to eat an increased amount of meat, and in the course of a few weeks the infant was thriving and gaining in weight.

The next case (Case 71) is that of a wet-nurse whose infant was digesting well, gaining in weight, and happened to be of about the same age as that of the infant whom she was hired to nurse. In order to see if this nurse's milk would agree with the foster-infant, the nurse and her infant were brought to the house of the foster-child, and were comfortably lodged and plentifully fed. Twenty-four hours later both infants began to have

colic and green faecal discharges. An analysis (Analysis 21) of the milk showed a high percentage of proteids:

## ANALYSIS 21.

Fat . . . . .	3.19
Sugar . . . . .	6.40
Proteids . . . . .	3.11
Ash . . . . .	<u>0.15</u>
Total solids . . . . .	12.85
Water . . . . .	<u>87.15</u>
	100 00

The nurse was then given a lighter diet with a greater proportion of liquids, and was made to walk one mile twice daily. By weighing the infants just before and just after a nursing, it was found that they took from 90 to 120 c.c. (3 to 4 ounces) in fifteen minutes. The infants were then allowed to nurse for ten minutes. 30 c.c. (1 ounce) of sterilized water was next given to them, and they were then allowed to nurse for ten minutes longer. In this way I estimated that they were receiving in their stomachs 120 c.c. (4 ounces) of food in which the percentage of the proteids was under 2.5. The infants ceased to have colic, and the faecal discharges became normal. The nurse's infant was then sent away. Two weeks later the foster-infant was thriving, and, as another analysis (Analysis 22) of the milk showed a sufficient reduction of the proteids, the sterilized water was omitted.

## ANALYSIS 22.

Fat . . . . .	2.87
Sugar . . . . .	6.25
Proteids . . . . .	2.90
Ash . . . . .	<u>0.15</u>
Total solids . . . . .	12.17
Water . . . . .	<u>87.83</u>
	100.00

During the rest of the lactation the infant digested well and gained fairly in weight.

This young woman (Case 72), who has brought her infant to show you, is perfectly healthy, and is nursing her infant, which has been digesting well and steadily gaining in weight for some months. I wish you to see this infant in order that you should understand how at times an infant can thrive on what appear to be too high percentages of some of the solids in the milk. This is the analysis (Analysis 23) of her milk:

## ANALYSIS 23.

Fat . . . . .	4.11
Sugar . . . . .	5.90
Proteids . . . . .	3.71
Ash . . . . .	<u>0.21</u>
Total solids . . . . .	13.93
Water . . . . .	<u>86.07</u>
	100.00



In contrast to this woman (Case 72) is another woman (Case 73) who has brought her infant for you to see. The infant is evidently thriving. The mother is delicate and frail, and the infant is being fed by this healthy-looking wet-nurse. In the early part of the lactation the infant did not thrive, and, as the mother was so delicate, it was not deemed advisable to attempt to improve the quality of her milk. The interesting point in connection with this case is the inability of the infant to digest a poor milk and its ability to digest perfectly well this wet-nurse's milk, which in its analysis (Analysis 24) shows a very high percentage of fat and of proteids and a low percentage of sugar :

ANALYSIS 24.

Fat . . . . .	4.72
Sugar . . . . .	4.55
Proteids . . . . .	4.74
Ash . . . . .	0.19
Total solids . . . . .	14.20
Water . . . . .	85.80
	<hr/> 100.00

This mother who has brought her infant to see me to-day represents a case (Case 74) where I entirely failed to change the percentages of the elements in the milk. She had a moderate quantity of milk, and nursed her infant for two or three months. The infant did not gain, it had colic, and at times vomited. The analysis (Analysis 25) showed that it was in the class which I have designated as "bad :"

ANALYSIS 25.

Fat . . . . .	1.61
Sugar . . . . .	4.67
Proteids . . . . .	4.07
Ash . . . . .	0.17
Total solids . . . . .	10.52
Water . . . . .	89.48
	<hr/> 100.00

An increase of meat in this mother's diet and more exercise had no effect on the percentages of the elements of her milk, and the infant was therefore weaned. Soon after beginning to take a substitute food from the Milk-Laboratory the infant ceased to have colic, gained in weight, and it is now, as you see, in a healthy condition. The percentages of the elements in the substitute food which produced such an immediate change in the infant's condition were as represented in this prescription :

PRESCRIPTION 4.

Fat . . . . .	3.50
Sugar . . . . .	7.00
Proteids . . . . .	1.00

It was merely necessary to raise the percentages of the fat and sugar, and reduce that of the proteids, in order to produce this rapid and satisfactory result.

The next analysis (Analysis 26) which I shall show you is that of a woman's milk (Case 75), which is instructive for a number of reasons :

## ANALYSIS 26.

Fat . . . . .	2.30
Sugar . . . . .	6.65
Proteids . . . . .	2.57
Ash . . . . .	0.12
Total solids . . . . .	11.64
Water . . . . .	88.36
	<hr/> 100.00

You see that the percentage of fat is low, and that of the proteids is rather high. The infant (Case 76), with the exception of being somewhat constipated, was always well, gained in weight, and showed no digestive disturbance during the lactation. This was remarkable, as the mother's catamenia returned regularly during the lactation from the time that the infant was four months old. There was considerable flowing at the time of the catamenia, and the mother was habitually constipated and did not have a very good appetite. The infant did not seem to be affected by any of these conditions. The analysis of this milk was made from a specimen of the "middle milk," which was taken between the catamenial periods.

It may be of interest, in connection with what I have said concerning the variations in the milk which may arise from emotional causes and menstruation, to report the analysis of a milk of a mother and a wet-nurse where these influences appeared to produce certain chemical changes. The mother (Case 77) (Table 46, page 190), a healthy but rather delicate primipara, the period of whose pregnancy had been supervised by me with the greatest care, but whose temperament was subject to extremes of despondency and excitement, was delivered, after a short and easy labor, of a healthy boy (Case 78). She was exceedingly anxious to nurse her infant, but within a few hours after its birth she was seized with an uncontrollable fear that she would be unable to do so. In spite of all the assurances to the contrary which could be given to her, and the plentiful supply of milk which in due time came in the breasts, she remained in a very nervous, despondent condition. As the infant began to show decided signs of indigestion, I thought it best, before proceeding further, to investigate the composition of the milk. The analysis (Analysis 27) resulted as follows, and plainly showed the necessity of not persisting further, as it was evidently much altered from unavoidable nervous conditions, which seemed likely to recur through the whole of her lactation :

ANALYSIS 27.

(*Mother's Milk.*)

Fat . . . . .	0.62
Sugar . . . . .	5.80
Proteids . . . . .	4.21
Ash . . . . .	0.20
Total solids . . . . .	10.83
Water . . . . .	89.17
	<hr/> 100.00

Under these circumstances, a healthy wet-nurse (Case 79) (Table 48, page 191), whose own infant (Case 80) was strong and thriving, was employed, and the foster-infant immediately began to gain in weight and ceased to show any digestive disturbance. After a month, however, it was found not to have made its weekly gain, to be unusually restless, and to be having frequent faecal discharges. It was then discovered that the wet-nurse was menstruating, and on the second day this analysis (Analysis 28) of her milk was made :

ANALYSIS 28.

(*Wet-Nurse.*)

Fat . . . . .	1.37
Sugar . . . . .	6.10
Proteids . . . . .	2.78
Ash . . . . .	0.15
Total solids . . . . .	10.40
Water . . . . .	89.60
	<hr/> 100.00

The catamenia lasted about four days, and did not return for some months. The infant after the first twenty-four hours showed no disturbance whatever, soon began to gain, and was not affected by the subsequent recurrence of the catamenia. This analysis (Analysis 29), made one week after the catamenia had ceased, showed a decided change for the better ; that is, increased fat and decreased proteids. Forty days after the catamenia a still greater improvement was found in the milk, as was anticipated from the thriving condition of the infant. The change in the percentages is shown in this analysis (Analysis 30).

ANALYSIS 29.

ANALYSIS 30.

	Seven Days after Ca- tamenia.	Forty Days after Ca- tamenia.
Fat . . . . .	2.02	2.74
Sugar . . . . .	6.55	6.35
Proteids . . . . .	2.12	0.98
Ash . . . . .	0.15	0.14
Total solids . . . . .	10.84	10.21
Water . . . . .	89.16	89.79
	<hr/> 100.00	<hr/> 100.00

The following case (Case 81) is of considerable interest with reference to what I have told you in regard to the incompatibility of pregnancy



and lactation. Unfortunately, a full consideration of the condition of the milk cannot be presented to you, as it rapidly disappeared from the breast after the first analysis was made, and, before another specimen could be procured, had disappeared entirely.

The milk was taken from one of my patients who had been pregnant for three months and at the same time was nursing an infant (Case 82) nine months old.

## ANALYSIS 31.

Fat . . . . .	7.64
Solids not fat . . . . .	6.04
Total solids . . . . .	<u>13.68</u>

The infant at the breast was not thriving. It had been digesting its mother's milk perfectly and had been gaining in weight until the pregnancy had existed for some weeks. At the time the analysis was made the infant's digestion had evidently been weakened, and as a result it had ceased to thrive and was rapidly losing in weight.

This analysis will be found to illustrate several facts. In the first place, it represents a very rich food. The total solids are even greater than appear in most cows' milk, and the fat is almost double the percentage which is considered normal in both human and cows' milk.

It also shows that a food may be unusually high in the percentage of its total solids and yet not of a character suited for the nutrition of an infant. The explanation of this fact is that although for a time an infant may digest fairly well a rich food, yet that nature has provided that the percentages of the elements in its food should remain within certain limits. If these limits are transgressed, either by giving too low or too high a percentage of any of the solids in the food, the nutrition will be interfered with. In the latter case the digestive function of the infant actually becomes weakened, and the strong food soon begins to act as a foreign body. The absorption of the food is next interfered with, and the infant starves as readily on the strong food which cannot be absorbed as on the weak food in which the needed elements are lacking.

This analysis also represents a condition which, in the majority of cases of pregnancy, occurs after the first six or eight weeks,—namely, a much disturbed mammary equilibrium. The percentage of fat in proportion to that of the solids not fat is so entirely different from the percentages of the different elements in a normal milk that we may say that this milk of pregnancy represents a condition of profound disturbance.

This especial analysis must not be taken as a standard one for the milk of pregnant women, for, in all probability, analyses of milk under these conditions differ very widely, yet invariably show an absence of the normal percentages.

This next case (Case 83) (Table 49, page 191) represents a milk which could have been changed with comparative ease, provided that the mother had followed the directions given to her. She was a multipara, strong and vigorous, with a good appetite and a perfect digestion, and her life was entirely free from care. She had a plentiful supply of milk, but insisted on eating much more solid food during the puerperium than was compatible with keeping the elements of her milk in proper proportions. The infant soon began to be restless, and, although it gained in weight, it vomited at times and had colic quite frequently. An analysis (Analysis 32) of the milk showed what I had expected to find,—namely, a percentage of proteids too high for the proteid digestion of the infant.

## ANALYSIS 32.

Fat . . . . .	3.03
Sugar . . . . .	6.25
Proteids . . . . .	3.51
Ash . . . . .	0.12
Total solids . . . . .	<u>12.91</u>
Water . . . . .	<u>87.09</u>
	100.00

The mother, who was able to go out of the house, was told to walk two miles twice daily. I also ordered her diet to be regulated so that there should be a smaller proportion of solids than she was now having. Sterilized water was given to the infant in the middle of its nursing. For a few days the infant seemed to improve and was less restless, but in another week the symptoms of indigestion returned, and, suspecting that the proper proportions of the milk were again disturbed, I had another analysis (Analysis 33) made, with the following result:

ANALYSIS 33.	
Fat . . . . .	3.05
Sugar . . . . .	6.10
Proteids . . . . .	3.89
Ash . . . . .	0.16
Total solids . . . . .	13.20
Water . . . . .	86.80
	<hr/> 100.00

The percentage of the proteids, as you see, was now even higher than at the time of the last analysis. The mother declared that she had been walking up to the prescribed limits, but complained that the exercise tired her very much. It was very evident that the walking did not fatigue her sufficiently to influence her milk badly. I found, however, that she was not carrying out the rules which I had laid down for her diet, and had eaten freely of many rich foods. I then insisted on her leading a more rational life if she was to continue her lactation, and she promised that she would. The infant for the next few days ceased to have colic and was apparently perfectly comfortable. At the end of another week, however, the symptoms of a disturbed digestion returned in the infant, and I had to investigate still further the cause of the mammary disturbance. The mother had been carrying out all my rules as to diet, sleep, and exercise, but I now found that for walking she had used shoes with high French heels, and that she had blisters on her feet. Another analysis (Analysis 34) of what was practically a "foremilk" showed the low percentage of fat and sugar which might be expected in a "foremilk." The percentage of proteids was very high, considering that it was a "fore-milk."

ANALYSIS 34.	
Fat . . . . .	0.65
Sugar . . . . .	5.25
Proteids . . . . .	3.82
Ash . . . . .	0.18
Total solids . . . . .	9.90
Water . . . . .	90.10
	<hr/> 100.00

The mother was now made to exercise in shoes fitted to her feet and having low broad heels, and to carry out rigorously all the rules which I had given her in the early part of her lactation. From this time the unfavorable symptoms in the infant disappeared, and it gained in weight and digested its food well. One week after this change was made in her shoes the analysis (Analysis 35) of her milk showed that it was now in normal equilibrium, and that the percentages of its elements were such as to lead me to conclude that the condition of the infant's digestion had become normal.

ANALYSIS 35.	
Fat . . . . .	3.34
Sugar . . . . .	6.30
Proteids . . . . .	2.61
Ash . . . . .	0.16
Total solids . . . . .	12.41
Water . . . . .	87.59
	<hr/> 100.00



A few weeks later the infant again began to show symptoms of colic and general disturbance, and although the mother said that she had not been eating any food but what I had prescribed and that she was taking a long walk every day in properly fitted shoes, I knew by the high percentage of proteids which was shown by the analysis and by the condition of the infant that she was not telling the truth. I therefore decided that in the interests of the infant it would be better to wean it, which I did at once, and gave it a substitute food with a low percentage of proteids, on which it thereafter thrived.

**PROLONGED LACTATION.**—In what I am about to say regarding the extension of lactation beyond the normal period of twelve months I shall not include the more pronounced pathological conditions, especially of a nervous type, which occur in certain women under these circumstances. In healthy women the milk towards the end of a normal lactation has a tendency to return to the condition which we notice at the very beginning of lactation; that is, the product of the mammary gland becomes unstable and the percentages show a poor or a bad milk. In rare cases I have met with women whose milk remained of fair quality and who could continue their nursing into the second year without apparent detriment to themselves or to their infants. There is, however, no reason for thus continuing the lactation, even if the mother is healthy and the milk good, for at the end of the first year, human milk, whether good or bad, is not a food which is adapted to the corresponding stage of development of the infant's digestive organs. Unmodified cow's milk and starch in some form are much better adapted to the stage of development of the digestive organs of the second year, and should therefore at that time be substituted for human milk.

**MIXED FEEDING.**—It not infrequently happens to nursing women, when their general health is not in a normal condition, that the supply of milk, while good in quality, is not sufficient in quantity to satisfy the infant, and the question arises whether the mother's milk should be entirely given up, or whether it should be supplemented by other food. My experience is in favor of assisting the mother to nurse her infant during the earlier months of its life. I have found that where the substitute food is carefully regulated, this method is superior to that of withdrawing the mother's milk and feeding the infant exclusively upon a substitute food.

We have, on the one hand, a better opportunity for regulating the mother's milk, by increasing or diminishing the number of the substitute feedings, and, on the other hand, if the mother's milk agrees with her infant, an excellent opportunity for making our substitute food correspond to what nature has provided. We can regulate more intelligently the infant's feeding by this method than by any other which is known.

In arranging a mixed feeding we should in every case first have an analysis made of the mother's milk, and, if her milk has been agreeing with the infant, make the substitute food correspond to the maternal. I would also recommend the practice of having an analysis of the mother's milk made at an early period of her lactation, as soon as the mammary gland has acquired its equilibrium and when the infant is thriving. This is a very



important precaution, which may be of great use to us at a later period when the mother's milk may from many circumstances be disturbed or entirely lost. When such an accident happens, we know exactly what the composition of the milk was on which the infant was thriving, and can at once arrange a proper substitute food. As an illustration of the truth of this statement, the following cases (Cases 84 and 85) are instructive:

An infant (Case 84) was thriving on the milk of a healthy wet-nurse. One day, without giving any warning, the nurse left the house and never returned. The infant had to be put on a substitute food, as another nurse could not be procured. It was left in the middle of the hot weather without the food which had been so well adapted to its digestion. Unfortunately, the precaution of having an analysis made of the wet-nurse's milk had not been taken, and it was some time before I was able to substitute a food which would agree with the infant.

The second case (Case 85) was the one which I have already mentioned in Table 50, where the mother's milk, after careful management, had become fitted for her infant, and where the infant was thriving. One day the mother received a nervous shock from seeing the arm of another of her children dislocated. Within a few hours the milk entirely disappeared from her breasts and did not return. The analysis of her milk, which had been previously made, provided me with a guide by which I could at once have a substitute food prepared which would correspond to the food which the infant had been receiving from its mother. This was done, and the infant continued to thrive, showing no bad symptoms from the change of food.

There are certain points to be considered in mixed feeding. First, if the mother's milk is agreeing with the infant, the substitute food should be of the same composition. Second, if the mother's milk is fully digested by the infant but is lacking in certain nutritive qualities, the absence of which prevents the infant's nutrition from being normal, we should, after the first week, alter the composition of the substitute food so as to make it fulfil the requirements of nutrition by increasing the percentage of that special element in the substitute which is deficient in the composition of the maternal milk.

The times at which the substitute food should be given will depend upon the number of feedings which are found to be necessary in addition to the maternal feedings, and we should carry out the same principles in this mixed feeding that I have laid down for the general management of human breast-milk. If the mother's milk is lacking in quantity we should make the intervals between her nursings longer, and introduce one or two substitute feedings according as the age of the child requires shorter or longer intervals. If, on the contrary, the mother's milk is abundant, but either too strong or too weak, we should make the intervals of her nursings correspondingly long or short. In this way, with an accurate knowledge of the percentages which exist in the mother's milk, and with our power to change these percentages in substitute feeding, we can usually in a week or ten days regulate the substitute feeding of the infant to such a degree that the mother's milk will also agree with the infant, and the infant will thrive again.

WEANING.—There is no doubt that in a considerable number of cases occurring in the practice of physicians among civilized nations the mother's

milk appears to be entirely unfit for her offspring, and it becomes a question whether the infant shall be withdrawn from its mother's breast temporarily or entirely. In such an emergency the careful and repeated analysis of the milk will enable us to determine this question wisely.

I am convinced that a large number of infants are deprived of their natural food and weaned on insufficient grounds. We thus assist to keep up the resulting high mortality figures, and I believe that these figures will be sensibly reduced when, in consequence of our taking a more enlightened view of the subject, we increase the number of infants who are fed during the first three or four months of life upon a suitable breast-milk.

A particular reason among many for waiting at least three or four months before weaning is presented by the fact that the stomach, after growing rapidly, has by the fourth or fifth month become a more perfect receptacle both as to size and to function.

A number of nursing women find that at variable periods in the course of their lactation their milk begins to fail, and they are forced first to lessen the number of their nursings and then to wean entirely. The time, then, when the infant should be weaned almost always settles itself, without our intervention, at varying periods. The period of lactation, and the one which might be called physiologically normal, can, when the breast-milk remains of good quality and quantity, be carried through the first year with benefit. We have certain guides which aid us in determining the proper time for beginning to wean. Physiologically, we know that certain functions, such as that which converts starch into glucose, are but slightly developed in the early months of life, and that they are only gradually established during the first year, and not, as a rule, perfected and in a condition in which we can call upon them with impunity until the last two or three months of that year. A sign which aids us in judging the progress of this development of the functions is the appearance of the teeth, calling our attention to the fact that nature is preparing the infant to digest and assimilate a form of food different from that which it has thus far received by sucking. The presence of six or eight incisors corresponds usually in the normally developed infant to the full development of the pancreatic secretion.

A most valuable index which assures us that we need not be anxious to change the infant's food during the first year is the continuous increase in its weight, which, with a general healthy condition, results from a normal lactation. We must allow, however, for certain variations which in special cases are as important as is the rule to terminate the lactation at a definite period. The period of lactation may be curtailed or lengthened by a month or two according to the season of the year, the development of the teeth, or the condition of the child from illness or convalescence. Under such circumstances it may be wiser to feed the infant from the breast during the heated portions of the year, and to wean it in cool weather, before or after the hot season, according to the individual case. An interdental period is also preferable to a dental period, on account of the possible disturbances



which may arise in the latter and interfere with the proper actions of the new functions to which I have referred. In these exceptional circumstances, where there is any uncertainty as to the character of the milk which the infant is taking, a chemical analysis should be made at once, and repeated several times at intervals of a few days. These latter months, though not so difficult to manage intelligently as the early period of the infant's life, are much more likely to need careful supervision than the middle period, which, from its usually uninterrupted tranquillity, has been called the period of normal nutrition.

Where on account of an insufficient supply of milk in the mother the infant has for some time become accustomed to several meals of a substitute food daily, the matter of weaning becomes a very simple one, for we know that we have a food which will agree with it; but where we have to begin to wean directly and to adapt a food to the infant's digestive capabilities, as in cases of sudden failure of the milk or of sickness in the mother, this procedure becomes much more intricate, and is at times fraught with considerable danger. It is in these cases that an analysis of the milk made when the mother was in good condition often proves to be of great assistance.

The method of weaning which I have adopted, and have found to be the safest and best, is the one which I have been enabled to use since having a milk-laboratory at my command. My rule is, provided that the infant is thriving or digesting its mother's milk well, to order from the laboratory a substitute food the percentages of the elements of which are very similar to what the infant has been taking from its mother. After a few days, if this food is agreeing with the infant, I begin to change the percentages of the different elements, with the object of gradually combining these percentages in such a way as to correspond to the percentages of the elements of unmodified cow's milk. This is easily and precisely accomplished. For instance, supposing that the infant is receiving from its mother a milk in which the percentage of the fat is 4, of the sugar 6.50, and of the proteids 2, I begin by giving the same percentage of fat (4), a lessened percentage of sugar (5.50), and an increased percentage of proteids (2.25). After a few days, if this milk is digested well by the infant, I make the fat 4, the sugar 4.50, and the proteids 3. In a few more days, if this food is digested well, I give plain cow's milk prepared by heating to  $75^{\circ}$  C. ( $167^{\circ}$  F.), with lime water sufficient to make it slightly alkaline. If this still agrees with the infant, I soon change to cow's milk unheated and unmodified.

Unless under very exceptional circumstances, sudden weaning is to be deprecated, though of course we must admit that it is sometimes done with impunity. The safest method, so long as we cannot judge beforehand which infants will be likely to be unfavorably affected by sudden weaning, is to take plenty of time and gradually ascertain by frequent changes, such as I have described, the food best adapted to the case. The infant should be gradually accustomed to this food, omitting the breast-feedings one by one, until finally we are sure that we have a substitute food on which it



will thrive. At the tenth or eleventh month, provided that the weaning of the infant is deemed desirable at so early a period, and after having accustomed it to taking plain cow's milk, starch in some form can also be given. It will be necessary to determine how much of this new element may be introduced into the infant's diet, carefully adapting the amount to its amylolytic function, which varies in different infants, and which has but lately arrived at its full development. When these changes have been accomplished, the breast can with safety be entirely withdrawn.

The danger of injudicious weaning was strongly impressed upon me in a case which I watched for several days through the courtesy of Dr. Sinclair, of Boston, and which it seems well to put on record.

A delicate infant (Case 86), backward in its development, digesting well, and a little over one year old, was, without Dr. Sinclair's advice, suddenly deprived of the plentiful supply of breast-milk of its healthy mother and fed on oatmeal gruel. Vomiting and prostration immediately began, and continued until the oatmeal was omitted and the breast-feeding resumed, when the infant began to thrive again. Three weeks later the mother, through ignorance, suddenly and without any preparation fed it again on oatmeal gruel. On the following two days the infant vomited incessantly and was much prostrated. Several changes were then made in its food, but the symptoms grew worse, and the now thoroughly terrified mother again put the infant to her breast, with, however, this time a disastrous result, as her milk from nervous influences was so changed in its quality that it acted like a poison on the infant, who fell into a condition of collapse. Dr. Sinclair was sent for, and a few hours later I saw the case. A wet-nurse with a healthy infant four months old was immediately procured, and after several days of complete prostration the foster-infant began to revive, and later was gradually weaned without trouble. It may be well to add, for the encouragement of physicians who have cases of this kind to deal with, that after the mother's milk had poisoned the infant, and when I first saw it, the skin was gray and cold, the fontanelle sunken, and the eyes fixed, yet recovery took place. Under the same circumstances equal success in the treatment would probably be obtained by writing for a milk prescription to contain fat 2.50, sugar 5, proteids 1. This, of course, would be an exceedingly weak food for an infant twelve months old, but it would be the safest combination to begin with, and could be increased in strength as the infant recovered.

**II. DIRECT SUBSTITUTE FEEDING.—WOMEN.**—Where for any reason it is impossible or inadvisable for the mother to nurse her infant, some other food must be substituted for the maternal. The milk of another woman approaches the mother's in its characteristics most closely, and should be obtained unless contra-indicated.

It is generally supposed that the mother's milk, as a rule, is more likely to be suited to her infant's digestion than the milk of another woman; but we have as yet too few cases where direct investigation by means of chemical analysis of the two kinds of milk has been made to lay down actually as a fact what we can merely grant as a supposition, that an idiosyncrasy in the mother's milk will find an analogue in her infant's digestive powers. The reverse of this proposition has also been held to be true, that at times some idiosyncrasy in the mother's milk will make it radically unfit for her infant. The probability, however, is that analyses will show either that these varieties of milk are poor ones, or that the infants have unusually weak digestive powers.

The fact that every mother cannot provide as good a milk for her infant as can be supplied by another woman finds its analogy in the inability of Jersey cows to rear their own calves.

In connection with what I have said about an infant sometimes having an idiosyncrasy of digestion corresponding to some unusual percentage in its mother's milk, this case (Case 87) will be of considerable interest:

The mother, a primipara, was healthy, but of a highly nervous temperament. The infant was thriving, but, as a measure of precaution in case of mammary disturbance at a later period of the lactation, I had an analysis (Analysis 36) made of the milk, with the following result:

ANALYSIS 36.

Fat . . . . .	5.16
Sugar . . . . .	5.68
Proteids . . . . .	4.14
Ash . . . . .	0.17
Total solids . . . . .	15.15
Water . . . . .	84.85
	<hr/> 100.00

The report made by Dr. Harrington in connection with this analysis was, "The precipitated curd is quite similar in its appearance to that obtained in the analysis of cow's milk."

I advised the mother on general principles to take more exercise, and ten days later another analysis (Analysis 37) of the milk was made.

ANALYSIS 37.

Fat . . . . .	4.88
Sugar . . . . .	6.20
Proteids . . . . .	3.71
Ash . . . . .	0.19
Total solids . . . . .	14.98
Water . . . . .	85.02
	<hr/> 100.00

The second analysis was so similar to the previous one that, in conjunction with the perfect digestion and health of the infant, I concluded that this infant had an idiosyncrasy of digestion which enabled it to thrive on what would in most cases cause extreme disturbance. This view of the case proved to be correct, as the infant, which was under my care for a number of months, continued to thrive. If you will compare this analysis with that of the milk of the wet-nurse (Table 45, Analysis III., page 190) which I have previously described to you, where the high percentage of proteids caused vomiting of thick curds in the infant, you will be impressed with the striking similarity of the two milks. There is no doubt that in the majority of cases a milk such as is represented by these two analyses would be totally unfit, and would not only cause marked indigestion but often more serious results, such as convulsions.

The following case (Case 88) presents an illustration of the reverse of the supposition that the mother's milk will suit her infant's digestion better than the milk of a wet-nurse:

This infant (Case 89) was being nursed by its mother and showed continual disturbance of its digestion. At times it would be constipated, and again it would have attacks of colic with watery discharges. The colic was the most prominent symptom, and the child, though looking fairly well, was not gaining in weight. An analysis of the mother's milk showed



that the percentage of fat was from 2 to 3, the sugar was of about the normal percentage, and the proteids varied from 3 to 3.50 per cent. The mother was of an extremely nervous temperament and was unwilling to carry out the rules for the management of her milk, which were absolutely necessary in order to reduce the high percentage of proteids, which evidently caused the disturbance. I therefore procured a wet-nurse, the analysis of whose milk was as follows :

ANALYSIS 38.

Fat . . . . .	2.96
Sugar . . . . .	5.78
Proteids . . . . .	1.91
Ash . . . . .	0.12
Total solids . . . . .	10.77
Water . . . . .	89.23
	<hr/> 100.00

The infant on taking this new milk ceased to have colic, but was more constipated and did not gain in weight. I therefore decided that it would be wise to increase the percentage of the fat in the nurse's milk. This was done by giving her considerably more meat to eat and making her take moderate exercise. The infant within a week began to gain in weight and to sleep well, the bowels ceased to be constipated and were moved naturally every day. There was also a plentiful supply of milk. Another analysis of the milk was then made, with the following result :

ANALYSIS 39.

Fat . . . . .	3.31
Sugar . . . . .	6.45
Proteids . . . . .	2.36
Ash . . . . .	0.16
Total solids . . . . .	12.28
Water . . . . .	87.72
	<hr/> 100.00

This last analysis is of great significance. The increase in the percentage of the fat evidently regulated the faecal movements. The total solids increased from 10.77 to 12.28, and the plentiful supply of milk made the infant gain, especially as it now was digesting perfectly. You will observe that it could digest a milk with a percentage of proteids below 2.50, while it was a percentage of 3 in the mother's milk which prevented her from carrying on her lactation.

In this case it will be seen that the milk of another woman was far preferable to that of the mother, and that the idiosyncrasy of a high percentage of proteids in the mother's milk did not find its counterpart in an idiosyncrasy in the proteid digestion of her infant.

WET-NURSES.—The general question as to whether a wet-nurse shall be employed is one which is of serious import, and must in each instance be decided by giving full weight to all of the many circumstances which are involved in the case. Foster-feeding, where all the conditions are good, is superior to substitute feeding. The reverse of this statement, however, must always be kept in view, that a poor nurse, whether from temperament, or age, or general health, or the quality of her milk, had better be set aside where the conditions are favorable for a successful substitute feeding. It is perhaps better that the nurse's milk should correspond in age somewhat nearly to that of the infant she is to suckle, but a difference of some months in age may not be a contra-indication, as we are not yet in a position to say



definitely that the milk differs sufficiently in different months to make this a reason of importance in choosing a nurse. A feeble child will nurse more easily and probably have better care from a multipara than from a primipara. The preferable age of the nurse is between twenty and thirty years. Her other requisites are a condition of good health and a quiet temperament. It will save much trouble and often obviate the frequent necessity for changing if before her engagement we have made a chemical analysis of her milk; in fact, all the points which have been already referred to for a successful maternal nursing are of equal significance in the case of a wet-nurse.

The general health of the wet-nurse should be carefully investigated, as women suffering from constitutional syphilis or any chronic disease are manifestly unfit for nursing. At the same time we should be careful, unless decided symptoms of disease are present, not to set aside the milk of a delicate-looking woman until it has been analyzed. The wet-nurse (Case 89) whose milk proved to suit the infant better than did its mother's was a frail, delicate-looking woman, but healthy. The mother, on the other hand, was a large, strong-looking woman, but of a very nervous temperament. The rapid progress which is being made in the detection of the bacillus tuberculosis, not only in the sputum but also in the milk and in other secretions, may in the future be of much practical importance in the determination as to whether a woman should nurse an infant or not, but the present state of our knowledge is only sufficiently advanced for us to state that this bacillus has been found in the secretion of the mammary gland.

**Diet.**—The same general principles that I have given in speaking of the diet of the mother should be applied to that of the wet-nurse. We should be extremely careful not to change suddenly the customary diet of a healthy nursing woman on purely theoretical grounds. For many years the mistake was made of keeping women on too low a diet in the early period of lactation, with the consequent delay of the establishment of a sufficiently nutritious milk-supply, and a corresponding initial loss of weight in their infants. Where, however, we are especially likely to err is in permitting a healthy, hard-working wet-nurse, accustomed to a somewhat coarse but nutritious diet, to adopt totally different habits of exercise and a diet to which she is unaccustomed, rather than to have her continue her usual mode of life. This sudden change of habits frequently results in loss of health to the nurse, with its accompanying deterioration in the quality of her milk, or at least a change in its quality so as to make it an unfit food for her foster-child. A notable instance (Case 90) of too radical a change of habits was brought to my notice by Dr. Swift, of Boston.

A wet-nurse had been procured for an infant (Case 90) ten days old. An analysis (Analysis I.) of her milk, two days before she began to nurse, is seen in the following table (Table 53). Her milk was digested well for two or three weeks, during which time she was fed on an abundance of good food and rich milk. The infant then began to

vomit thick curds identical in appearance and toughness with the curds of cow's milk. Another analysis was made (Table 53, Analysis II.), which showed the amount of total solids to be increased in a most marked degree, the percentage of proteids corresponding far more nearly to that of cow's milk than to that of woman's milk. The nurse was then given plainer food and skimmed milk, and the infant ceased to vomit. The infant and nurse continued well and strong during the whole year, the infant making a weekly gain in weight.

I have here an analysis (Table 53, Analysis III.) of this same nurse's milk, made in the twelfth month of her lactation :

TABLE 53.  
(Wet-Nurse.)

	Analysis I.	Analysis II.	Analysis III.
	Two days before change of food.	Rich food for a month.	Food regulated and milk agreeing with infant.
Fat . . . . .	0.72	5.44	5.50
Sugar . . . . .	6.75	6.25	6.60
Proteids . . . . .	2.53	4.61	2.90
Ash . . . . .	0.22	0.20	0.14
Total solids . . . . .	10.22	16.50	15.14
Water . . . . .	89.78	83.50	84.86
	100.00	100.00	100.00

ANIMALS.—I shall merely allude to the other method of direct substitute feeding by means of animals. In parts of France, notably in Brittany, infants are put directly to the cow's teats, and sometimes with good results. I know of one family of eight children all of whom were nursed by the family cow, and all of whom grew up healthy and strong. Yet the undesirability of feeding human beings directly from the udders of animals is so manifest that this method need not be discussed.

I shall at my next lecture deal with the third division of the First Nutritive Period, which I have designated "Indirect Substitute Feeding."

## LECTURE VIII.

## THE FIRST NUTRITIVE PERIOD.—(Continued.)

## III. INDIRECT SUBSTITUTE FEEDING.

TO-DAY, gentlemen, I have asked you to meet me here at the farm connected with the Milk-Laboratory, in order that you should study practically what will be of great use to you in your future careers. I would impress upon your minds that in this subject of *indirect substitute feeding* we have many links of a long chain, all of which should be as nearly perfect as we can make them if we expect to obtain a satisfactory result.

**CHOICE OF FOOD.**—I have laid great stress upon the importance of feeding infants during the early months of life by means of human milk. We know, however, that in civilized communities the necessity will often arise for supplying the infant with food not from the human breast. In all probability the employment of substitute feeding will increase rather than decrease as our civilization advances. With this prospect before us, and appreciating the difficulties which in a large number of cases are liable to arise when we attempt to adapt a substitute food to the wants of an infant, it manifestly becomes a duty to endeavor to reduce the high mortality figures resulting from artificial feeding. With this purpose in view, we should carefully investigate different methods of feeding and adopt some more uniform plan for starting human beings in life; for diversity and not uniformity is now the rule. While inherited diseases contribute a certain proportion of the deaths which occur in infants, yet diversity of method in feeding is the most prolific source of disease in early infancy. The group of symptoms which for want of a better name is designated as difficult digestion occurs most frequently in the three periods when the infant's digestion is likely to be tampered with,—namely, in the early weeks of life, when experiments are being made to determine what food will be best to start with; next, when, in addition to the irritation arising from the beginning of dentition, new articles of diet are added to the original food; and, thirdly, at the time of weaning, when there is often a sudden and entire change in the character of the food. The proper management of the first of these periods is of the greatest importance, because it is the time when, as before stated, the stomach is in its most active period of growth, and when the function of digestion is being established, and, following the rule of functional establishment, is in a state of unstable equilibrium.

We should recognize the fact that the problem of substitute feeding is not a simple one. We cannot reiterate too often that the question which commonly is supposed to be a simple one, and the one which in the great



majority of cases is alone considered,—namely, “Which food shall we give to the infant?”—is a misleading and insufficient one. The problem is a combination of factors of which the kind of food is only one, and I personally have long been convinced that the neglect to investigate thoroughly and carry out in detail the combination of these by no means insignificant general factors has had much to do with our failures with substitute feeding in the past. It would seem, also, that the present is a most opportune time for raising a note of warning against allowing our enthusiasm over any one especial theory to warp our better judgment. There will surely be a reaction which will relegate to its proper place every theory built upon single factors of the problem before us, and which is actually doing harm by keeping in the background other theories which, each in its own sphere, as a significant part of a complete whole, may be of very great importance in the successful solution of the general problem. An error of oversight of one-eighth in a mathematical problem is not so great as one of one-fourth, but nevertheless the correcting of the greater error will not prevent an oversight of the smaller from completely destroying a correct result. Until lately it has been the quality of the food which has been monopolizing to too great a degree the attention of the medical profession. To-day it is sterilization which in feeding has become prominent. Already one of the latest German writers on substitute feeding has stated that the physiology and pathology of infantile digestion depend not on the chemical but on the biological character of the food. If we are not on our guard, this exaggeration of each single factor will prevail, and by its influence will blind us to much good work which in other directions has already been done, and which we cannot afford to ignore. Not that I would for a moment be understood to underrate the value of feeding an infant on a sterile food, for it has for years proved of very great benefit in my practice and that of others, but I predict that by just so much as we enhance the value of this one important part of the whole at the expense of others, just so much farther shall we be from an intelligent comprehension of the whole subject.

To feed an infant one month old with six ounces of acid cow's milk every four hours, no matter how thoroughly such a mixture has been sterilized, would be a radical offense against well-known anatomical and physiological laws. It therefore seems to me that time will be well spent in the discussion of the subject of substitute feeding, if we investigate and endeavor to copy, each in its turn, the various devices which nature makes use of, for we must admit that we are not in a position to improve on nature's method.

It is certainly wiser and more economical not to spare expense and trouble in arranging the infant's diet, for, as I have explained, the period of active growth of an organ is the time when its function is readily weakened, and, when once weakened, the digestive function is a prolific source of annoyance and expense in childhood and adolescence.—Cheap foods and cheap methods of feeding, unless they are the best that can be procured, should not be tolerated in the early feeding of infants. We often, however,

see a food recommended for a young infant because it is cheap and easily prepared, in spite of the fact that its well-known lack of nutritive ingredients would with adults stamp it as unfit for use.

In discussing the treatment of disease we advocate what is best, without reference to what it costs, and then, in the special case where expense is an element which has to be taken into consideration, we endeavor to adapt our treatment to these considerations, and approach as nearly as possible to our first standard. In like manner I believe that we are doing wrong to the public if we allow ourselves to be handicapped in so difficult a question as infant feeding by the cry of expense. Infant feeding is an expense which is vital to the welfare of the human race, and we can, without being accused of extravagance, safely relegate to the province of the manufacturers of patent foods the recommending to the public of foods which if judged by the amount that is offered in bulk are cheap, but which when judged by their nutritive properties are extremely expensive.

Our scientific knowledge and clinical investigations have not yet enabled us to follow nature exactly, and we therefore have not yet obtained an ideal method of substitute feeding. We must, nevertheless, go as far as the present state of our knowledge will allow, thus gaining a little ground every year; and we must be especially careful not to be led astray by the fictitiously brilliant results which are reported from time to time in favor of certain foods. Instances are continually occurring where one food will fail and another, when substituted for it, will succeed, and yet these successes are merely temporary, and the mortality resulting from the use of various infant foods always remains far above that from the employment of human breast-milk.

**SOURCE OF FOOD.**—Having decided to substitute some food in place of woman's milk for the infant, we must decide from what source the elements of this food shall come. The food which approaches most nearly in every respect the product of the human mamma is that produced by the mammæ of other animals. The reason for this is that the food which all mammals provide for their offspring is an animal one, and consists of the same elements, although the mammary product of different animals varies in the percentage of these elements.

Assuming, then, that average human breast-milk is the safest standard for us to copy, we are impressed with the fact that although a vegetable diet would often seem far the easiest method of procuring nourishment for young infants, yet nature has persisted in providing an animal one. We should therefore be very careful not to introduce into our substitute diet a vegetable element, which, as judged by our standard, must be a foreign element. Milk is the food which our reason tells us should be given to the young infant, and a milk which will approach as nearly as possible to the average human milk. That of various animals has from time to time been recommended as the best substitute for human milk, the recommendation being based on their analyses approaching more or less nearly the composi-



tion of human milk. The milk, however, of all animals has to be modified to correspond to human milk; and when we begin to modify, it is as easy to change the proportions of the different constituents to a great degree as to a small. The fact that the milk of any particular animal approaches in its analysis nearly to that of the human breast is not of much significance, other considerations being far more important; and it is most important of all that we should use one which can be obtained easily by the people at large. This at once settles the question that it is the milk of the cow to which we must turn our attention. Cow's milk may differ in its composition from human milk to a greater degree than does the milk of the ass or the mare, whose milk approaches, so far as is shown by analyses, most nearly of that of all animals to human milk; but this in all probability is for the very reason that cow's milk is so universally used as a food for human beings of all ages.

If the ass and the mare should be employed for dairy purposes to the same extent that the cow has been, there is every reason to suppose that their milk might change in its composition and their comparatively undeveloped mammary glands increase in size, just as has been the case with the cow, an animal which for thousands of years has been used for the production of milk, and which probably did not in the beginning give such an over-production of the mammary secretion as is the case now. In fact, on the monuments in Egypt, where formerly there was either no trade in milk or very little, we find represented cows with only slightly developed udders, while the generative organs of the male animals are clearly depicted, a fact of some significance when we remember the well-known tendency of the Egyptians to realistic representations. It is, then, from the public demand, and by breeding, that cows have been made to produce so much more milk than is necessary for the support of their young. Not only quantitative but qualitative differences exist in animals according to the development of their mammary glands; and, as Martiny has shown in his collection of statistics on this subject, the condition which determines the quantity and the quality of the milk depends on the development of the organ which produces it. The question of substitute feeding, then, is reduced practically to some modification of cow's milk, for this is the milk which is procured most easily everywhere, and, as the milk of all animals must be modified for the human infant, it is as easy to deal with cow's milk as with any other.

A further exemplification that cow's milk is practically the universal source of the substitute food-supply for infants in most civilized communities is the fact that the various foods, patent or not, all depend for their basis on cow's milk, and that without this addition of milk they would show but an insignificant percentage of many of the most important ingredients of the food. Logically we should not speak of the various foods as such, but merely as adjuvants to cow's milk. If this is thoroughly understood, much misapprehension regarding the apparently successful results of innumerable foods will be done away with.



One of the principal reasons for using eow's milk in preferenee to all others is that the cow has been kept under more strict control than any other animal has ever been.

As I shall in a later leecture (Lecture X., page 278), when speaking of home modifieation, have to refer to the neccessity of using milk from common cows on any farm, it will be well for you to know what the average analysis (Analysis 40) is of milk taken from large numbers of eommon eows all over the world. This average analysis represents the work of well-known chemists, such as König, Forster, and others.

ANALYSIS 40.

*Average Cow's Milk.*

Reaction . . . . .	Slightly acid.
Specific gravity . . . . .	1029-1033
Water . . . . .	86-87
Total solids . . . . .	14-13
Fat . . . . .	4.00
Sugar . . . . .	4.50
Proteids . . . . .	4.00
Total ash . . . . .	0.70
Chlorine . . . . .	13.45
Sulphur . . . . .	0.41
Phosphoric acid . . . . .	27.98
Iron oxide and alumina . . . . .	0.44
Lime . . . . .	23.17
Magnesia . . . . .	2.63
Potassium . . . . .	53.00
Sodium . . . . .	4.49

The differencees between the eonstituents of the ash of human milk and of that of eow's milk are as follows: in eow's milk there are more lime, magnesia, potassium, much more phosphoric acid, and less ehlorine and sulphur.

**THE COW.**—Having ehosen the eow for our primal milk-supply, we must eonsider whether any special breed is better adapted than others for aeeomplishing our purpose. To do this we should first examine chemically and mieroseopically the elements of the milk of those breeds which can be employed best throughout the eivilized world. It has been found that the finer breeds of eows from the Channel Islands are more liable, when transported from their home to eountries where the climate is more severe, to contract diseases, such as tuberculosis, than are the animals represented by the Durham, Devon, Ayrshire, and Holstein breeds. The characteristic analysis of the milk of the finer breeds, such as Jersey and Guernsey, is represented in this table (Table 54) in eomparison with that of the milk of other breeds; the difference being mostly in the pereentage of fat and slightly in the proteids. It may be well to state here that the pereentage of protcids in the milk of pure Holsteins is also a little higher.

TABLE 54.  
*Cow's Milk Analyses.*

	Jersey, Guernsey.	Durham, Ayrshire, Devon, Holstein.
Fat . . . . .	5.50	4.00
Sugar . . . . .	4.50	4.50
Proteids . . . . .	4.25	4.00
Ash . . . . .	0.65	0.65
Total solids . . . . .	14.90	13.15
Water . . . . .	85.10	86.85
	100.00	100.00

It is for future research to determine whether there is a qualitative as well as a quantitative difference between the fat secreted in the milk of the Channel Islands and that of the more common breeds, but at present it would seem wiser, in choosing our medium for modification, to select the milk of the hardy breeds of cows.

A cow whose milk is to be used for purposes of infant feeding should be properly housed and well cared for, as the domestic cow is an animal peculiarly sensitive to her surroundings, and her product is correspondingly liable to be thrown out of equilibrium. The milk product of a herd of healthy cows is much less liable to the variations so injurious to the infant's digestion than is the milk of any one cow. It is especially to be noticed how much easier it is by proper care to control exaggerated nervous influences upon the cow's product than upon the woman's. This at once suggests to us the question, where and how shall cows be taken care of?

The ordinary cow is allowed to range over wide pastures which are sometimes over-flushed with herbage and sometimes parched by drought, and which nearly always contain noxious weeds, which she seems eagerly to seek. Again, she is forced to drink from stagnant pools and polluted streams, and at other times suffers for want of water for many hours together. She is also frequently exposed to storms. Cows cared for in this way are not those which provide the best milk for substitute feeding. These are the adverse conditions which surround the ordinary cow during the summer. In the winter she is crowded in the stifling atmosphere of a close barn with the manure of the whole winter kept underneath the floor on which she stands. Her head is usually confined in a narrow stall. The fodder intended for the winter's supply is kept above her head, and is continuously contaminated by the foul odors of the barn. She is turned out to the watering trough at periodical intervals. Thus she cannot be said to be cared for in a manner conducive to the equable function of her mammary gland.

For cows to be used for the purpose of infant feeding a barn is needed where each cow shall have at least fifteen hundred cubic feet of fresh air. The food should be kept where it cannot be contaminated. The manure should be as carefully removed from the barn as if it were a human dwelling. The cow should have freedom for her head and limbs in wide stalls all the

year round. Large, dry, sunny exercise-yards should be provided for her. Her food should always be brought to her and selected with great care. Pure water should be provided, and suitable cups or troughs containing running water should be in her stall. The bedding should be fresh and free from mould or from any soil productive of bacterial growth. This can be accomplished best by means of sand or dry soil constantly changed at least twice a day. Methods should be used to get rid of all the usual foul odors and free ammonia so commonly produced in barns. Cows should be carefully guarded against fright, the worrying of dogs, and unusual excitement of all kinds, which cause serious disturbance of the lacteal functions of domesticated cows, in contradistinction to those of cows in a more natural condition, as for instance the cows in a semi-wild state on the plains of Montana, Texas, Australia, and the Pampas of South America. Excitement does not apparently injure the lactation of these cows, while it inevitably throws out of equilibrium the milk of the well-cared-for dairy cow. If the same care should be applied to regulating the woman's life as is employed here in this barn with these cows, we should encounter fewer difficulties in human breast-feeding.

The feeding of the cows of this farm has for its object the production of an even, nutritious, digestible milk and the careful avoidance of over-stimulation of the lacteal secretion. For this purpose a somewhat wider ration than that employed for the production of milk to be used in butter-making, but somewhat narrower than that employed for the production of beef, has been found to be the best adapted. For example, a ration for the production of butter fat up to the limit of the cow's capacity would be in accordance with the ratio of Wolfe so often employed,—namely, one nitrogenous part to four and a half non-nitrogenous. The ration for the production of beef in its most economical manner would be that used by English feeders as prescribed by Lawes,—namely, a proportion of one nitrogenous to eight non-nitrogenous parts. The ratio which has been demonstrated to produce the best milk for infant feeding is the mean between these two,—namely, one nitrogenous part to five and a half or six non-nitrogenous parts. A constant use of this ratio in the combinations of many fodders and grains appears to have produced a reasonably large supply of milk with fair richness, but without over-stimulation such as would be shown by a disturbance of function. Nitrogenous foods for cows are the leguminous groups of grasses and plants, such as the clovers, lucern, beans and peas, vetches, and other plants of like kind. Besides these fodders we have for nitrogenous foods suitable for producing milk for substitute infant feeding, such grains as wheat-bran, oil-meal in small quantities, and pea- and bean-meal. Of the non-nitrogenous fodders the principal ones are maize-stover, the hays from timothy, red top, orchard grass, Johnson grass, rye grasses, the bents, Kentucky blue grass, June grass, and oat straw. Most of the grasses in a green state afford a fairly balanced medium ration for substitute feeding. Of the non-nitrogenous grains the most suitable is maize-meal. We also have oat-



meal and barley-meal, which contain less of the non-nitrogenous elements than the above, but still must be classed with them. The exact chemical analysis of any one ration used for feeding cows for our purpose must be carefully considered in accordance with the ratio of the digestible nutrients of the food, and this must of course be arranged practically from the recognized food tables. A great variety of food is necessary in feeding cows, but in the transition from green foods to dry, or the reverse, much care is needed to graduate the change, as disturbance in the equilibrium of the mammary gland is rapidly followed by injurious effects on the consumer. In past times, before I could rely as I do now on this carefully-managed change of rations, the spring of the year with its flush pasturage and the fresh grass following the autumn rains were fruitful sources of infantile digestive disturbance in my nursery practice.

You will now appreciate how important are all these links in the chain which constitutes a successful substitute feeding. The cows must be kept clean by grooming and the necessary washing, the precaution always being taken to rub the moistened parts dry. The milkers should be dressed in clean white suits and caps. Their hands and arms should be thoroughly scrubbed before milking. The hands in milking should be kept dry. The milk should be drawn with some force, simulating the action of the calf, and at each milking every drop of milk should be drawn out. The milk should be drawn into glass-lined pails and carried immediately from the barn to the milk-house, which should be a sufficient distance from the barn to be free from odors. No means yet known to science can prevent some few bacteria coming into the milk during the milking-time, though it is possible to reduce the number so greatly as to make the milk practically sterile for the purpose of infant feeding, particularly if the second half of the product of the udder alone is used and milked into sterile tubes. The first half probably contains many bacteria, which, entering from without, have reached the lower portion of the teat.

**BIOLOGY OF THE MILK.**—The experiments on the biology of the milk of this special herd which I am showing you have been made by Professor Ernst and Dr. Jackson, and the results are shown in this table (Table 55). The specimens examined were taken from the mixed milk of the entire milk of the herd.

TABLE 55.

*Bacteriological examination of milk from the entire herd milking showed six hours after the milking sixty-eight thousand colonies.*

Specimen.	Heated to	Minutes.	Developed Bacteria.
Whole milk . . . . .	75° C. (167° F.)	10 and 20	0
Modified milk . . . . .	75° C. (167° F.)	10 and 20	0
Whole milk and modified milk .	65.55° C. (150° F.)	10 and 20	Numerous.

In striking contrast with these results obtained by experimenting with the entire milking are some special experiments made on this same milk by Dr. Austin Peters and Dr. A. K. Stone, at Mr. Gordon's suggestion, for the

purpose of deciding whether it was possible to obtain a practically sterile milk at any part of the milking. The manner of performing the experiments was as follows :

Dr. Peters was dressed in a freshly-boiled white suit and cap, and had his hands and arms thoroughly washed with a 1 to 1000 bichloride of mercury solution. The cow's udder, teats, flanks, sides, groins, and abdomen were washed with the same solution, and dried with a freshly-boiled cloth. The milking was then done by Dr. Peters into bottles which had been carefully sterilized at the bacteriological laboratory, with the following result.

Of the four cows milked for this experiment and selected without special choice, the bottle marked 1 in each of the following sets of figures in this table (Table 56) represents the milk of the first half of the milking and drawn by the hand of the milker directly into the sterile bottles. Number 2 in each set of figures represents milk drawn through a sterile canula directly into the bottle, while numbers 3 and 4, respectively, represent milk drawn by hand after more than one-half of the udder had been emptied. A bacteriological examination of the milk in these bottles, by Dr. A. K. Stone, gave the following results :

TABLE 56.

	Colonies.	Colonies.	Colonies.	Colonies.
1 . . . . .	141	167	19	53
2 . . . . .	0	0	1	2
3 . . . . .	0	6	0	0
4 . . . . .	0	0	1	2

The results of Dr. Stone's examination showed, first, that the milk obtained from the first half of the milking contained a comparatively large number of micrococci and fine bacilli of the same general appearance respectively ; second, that the milk drawn through the sterile canula was practically sterile, and that the milk drawn in the second half of the milking by hand was so uniformly sterile as to awaken the suspicion that the isolated colonies might have been the result of the manipulation between the "cow and the plate."

These experiments at once provide us with a means of procuring a milk practically sterile but not sterilized. This experiment also seems to prove that the bacteria which are found in cow's milk do not necessarily come from external sources, whether they be of the cow herself or of her surroundings, but may also come from some part of the milk tract between the udder and the end of the teat. These conclusions, it may be said, are made with reference to healthy cows.

Infectious mammitis, to some extent, seems clearly to be carried by the hands of the milkers from cow to cow. This also points to the fact that bacteria may find their way to the ducts through the teats.

These experiments are of great practical importance when it is considered that while under certain circumstances it is impossible to obtain the advantages of such a farm as this and the modification of milk by means of



laboratory processes, yet it may be of great necessity to the infant on account of sickness to be fed with a sterile fresh milk not sterilized. This could, of course, be accomplished on any farm with any cow by means of ordinary care in the milking, and by such rules as were carried out by Dr. Peters. The major part of the bacteria present in the milk are such as cause the usual acid fermentation which we recognize in the common souring of milk, but there are many species of bacteria which ought to be prevented from gaining access to the milk, arising from mouldy hay, straw, or fodder, partially decayed roots, and the natural decay of the wood-work of the barn and adjoining buildings. These latter varieties, which are found to be especially inimical to the preparation of substitute foods, cause in some cases the alkaline fermentation and other abnormal conditions of milk. Every barn apparently has its own set of bacteria, and the flora in America do not exactly resemble the analogous European species which have so often been described.

REACTION OF COW'S MILK.—It seems to be true that milk drawn from cows fed on the better grasses in a half-ripe condition is nearly or quite alkaline, while the milk from stall-fed cows, where dry fodder and grain only are used, is inclined to be acid.

It will perhaps be interesting to you, inasmuch as grass feeding is not always practicable, to hear what has been done to produce a normal cow's milk which is alkaline and thus corresponds to normal human milk.

The importance of the subject lies in the well-recognized fact that the infant's digestive functions have been from time immemorial better adapted to the digestion of an alkaline or a neutral fluid than of an acid one. Whether the moderately alkaline reaction of human milk is an important factor in the problem of infant feeding is a question which future investigation alone can completely prove, but with our present knowledge we are not prepared to dispense with even the least important of the many factors which make up this problem. At any rate, we should be very suspicious of a breast-milk which shows an acid reaction. In the preparation of an infant's food from cow's milk, according to the latest experiments by means of modification, the best results have been obtained by making the reaction of this food correspond to that of normal human milk. This, up to the present time, has been done best by the addition of an alkali, which is the only foreign element that it has been found necessary to employ.

My attention was first drawn to the possibility of obtaining an alkaline cow's milk corresponding in its reaction to that of human milk by Mr. G. E. Gordon, who, by his extended and intelligent investigation of this subject carried on for so many years, has given such a stimulus to these questions of clinical interest. Many years ago it was noticed that cows fed on certain pastures, such as occurred in Kentucky, represented by the Kentucky blue grass, and also in many other parts of the West, produced at the height of the season of such grass a product which was alkaline rather than acid, and which remained alkaline for a number of hours after milking. It is also of



course well known that milk in general, wherever it is produced throughout the world, has an acid, or at least an amphoteric, reaction. This information at once incited the investigation of the food values which existed in these peculiar pastures. A careful analysis showed that the nitrogenous elements of this grass bore a certain proportion to its non-nitrogenous ones,—namely, about 1 to 4.5. We should naturally suppose that if we combined nitrogenous and non-nitrogenous foods in the proportion of 1 to 4.5 the product of cows fed upon this combination would resemble closely the product of cows fed upon the pasture grasses already mentioned. This to some extent has proved to be true, but not so completely as is to be desired for the precision needed in infant feeding. It is therefore interesting to record that the experiment of supplying the non-nitrogenous proportion of the food with sugar-beets (ten pounds to each cow daily) of the highest saccharinity has accomplished unlooked-for results. The cows which were experimented with in obtaining these results were under observation for three months, and were cared for in the same barn and under the same general conditions. Two-thirds of this herd were fed on hay and grain combined in the ratio of 1 nitrogenous to 4.7 non-nitrogenous parts. The remaining third of the herd was also fed according to the same ratio, but this ration, so far as the non-nitrogenous elements were concerned, was made up partly of Austrian sugar-beets grown for this purpose. No beets were given to the first two-thirds of the herd just spoken of. During the three months when the experiments were being made, the reaction shown by the milk to common litmus paper was constantly as follows: the milk of the cows fed partially on the beets exhibited a neutral or feebly alkaline reaction, while that of the cows that received no beets showed a somewhat acid reaction.

A still more delicate test of the reaction of the milk of the entire herd was made by Dr. Austin Peters, of Boston. Hay and grain without beets, as previously stated, had been the food of two-thirds of the herd, and ten pounds of beets to each cow daily had been fed to the remaining third.

The results of the testing of the alkalinity of this milk at the various stages of the experiment were as follows. The milk of the cows which had been fed with beets, when tested directly by Dr. Austin Peters as it was milked into the pails and where it had a temperature of  $33.88^{\circ}$  C. ( $93^{\circ}$  F.), invariably gave the following reactions:

Blue litmus paper gave no change whatever.  
Red litmus paper was turned slightly blue.  
Cochineal and ammonia paper turned still bluer.

The mixed milk of the whole herd in the vat and at a temperature of  $5.55^{\circ}$  C. ( $42^{\circ}$  F.) was then tested by Dr. Peters, with the following results:

Blue litmus paper showed no change.  
Red litmus paper was turned slightly blue.  
Cochineal and ammonia paper was turned still bluer.

Finally the mixed milk of the whole herd, after being carried twelve miles to the Laboratory, was tested by Mr. Gordon with cochineal and ammonia paper; the paper was found to turn just as blue as when the milk was tested in the vat at the farm.

These experiments are of great interest as showing that not only can the product of the cow, so far as its reaction is concerned, be made to correspond to that of human beings by means of perfectly natural feeding and under perfectly normal conditions, but that this alkaline modification can be produced to such a degree that one-third of the milk is sufficient to destroy by its alkalinity the acidity of the remaining two-thirds.

**THE MILK-HOUSE.**—After the cows are milked, the milk is carried quickly from the cow to the milk-house, which in this instance is over a hundred yards from the barn and is completely isolated from all other buildings. To prevent the milkers from going into the milk-room, the milk is poured by means of a block-tin pipe through the wall of the milk-room into a large ice-lined block-tin tank, which is also the mixer for the milk of the entire herd. In the space of four minutes, by means of an ice-jacket, the milk is cooled from  $33.88^{\circ}$  C. ( $93^{\circ}$  F.) to below  $4.44^{\circ}$  C. ( $40^{\circ}$  F.). This is to rapidly remove the heat, which is conducive to bacterial growth. The milk passes through eight thicknesses of sterilized gauze on its way to the tank.

The milk-room is practically clean from a bacteriological stand-point, for the walls and floor are kept wet with clean water, and all dust is excluded. The milk is drawn into these jars (Fig. 50, page 246), in which it is to be transported. The jars are then sealed, packed in ice, and in a few hours delivered at the place where the milk is to be used for substitute feeding.

After this treatment of the milk I have had repeated bacteriological examinations made on its arrival at the Laboratory, with the uniform result that it has proved to be comparatively sterile, and at times it has contained either no colonies of bacteria or only one or two.

No antiseptic can, without danger to the infant, be used about the cow, while all the mechanical devices heretofore tried to take the place of manual milking have inevitably tended to impair the lacteal function of the udder.

**CHARACTERISTICS OF COWS WHICH PRODUCE MILK SUITABLE FOR INFANT FEEDING.**—Some of the marks which distinguish the breeds best adapted for infant feeding are:

- I. Constitutional vigor.
- II. Adaptability to acclimatization.
- III. Notable ability to raise their young.
- IV. Freedom from intense inbreeding.
- V. A distinctly emulsified fat in the milk.
- VI. A preponderance in the fats of the fixed over the volatile glycerides.

You must understand that the volatile glyeerides do not exist in the mammae, but are formed in the milk soon after the milking, and that in some breeds this occurs more quickly than in others, such as those from the Channel Islands.

By means of these distinguishing marks we can eliminate from the cows which we wish to use for infant feeding such breeds as the Jersey, Guernsey, and any others in which intense inbreeding has been carried on and in which acclimatization has not been perfected, leaving for our purposes such breeds as Mr. Gordon has here to show you,—namely, the Durham, Devon, Holstein-Friesian, Ayrshire, Bretonne, and Brown Swiss. These you will understand are types of the breed, though not in all instances pure bred. These breeds, of course, do not represent all of those available for substitute feeding, for we may mention many others equally good each in its country. For example, the Kerry of Ireland, the Red Polled of England, the Dutch Belted and the Flemish, also the Flamande and the Cotentine of France, the Norman breed of Normandy, and, besides the Brown Swiss just spoken of, and which you will presently see, the Simmenthal, sometimes called Bernese, of Switzerland, also the Chianina of Italy, and the Allgauer of Germany. I say very little about the native eow of this eountry, the “Red Cow,” because through many generations of neglect and exposure in winter she has undoubtedly aequired an impaired digestion and does not respond readily to appropriate changes of food.

Mr. Gordon will now show you the types of those breeds which represent best in his herd the requirements of substitute feeding.

The first cow (Fig. 43) represents the best type of the milking Durham or Shorthorn. She has great constitutional vigor, great capacity for food, a perfect digestion, is of a placid temperament, not easily frightened, and yields a large quantity of rich milk, the analysis of which is as follows :

ANALYSIS 41.	
Fat . . . . .	4.04
Sugar . . . . .	4.34
Proteids . . . . .	4.17
Ash . . . . .	0.73
Total solids . . . . .	13.28
Water . . . . .	86.72
	100.00

The physical characteristics of the Durham are variety in color, a white nose (this especial Durham is a strawberry roan and white), large size, rather small head, large udder, and a placid, intelligent, and rather refined appearance.

The next cow (Fig. 44), the Devon, has the same general characteristics as the Durham, combined with great gentleness and docility. The color is, as you see, almost uniformly red, with the nose generally white. They are of medium size and have medium-sized udders. They are very gentle and very vigorous. They come from an old south-of-England established breed, and have been known for centuries. They have never been intensely inbred or pampered. They have a fair capacity for food, are not easily frightened, and their digestion is good. They give a moderate quantity of milk of medium quality, the analysis of which is as follows :



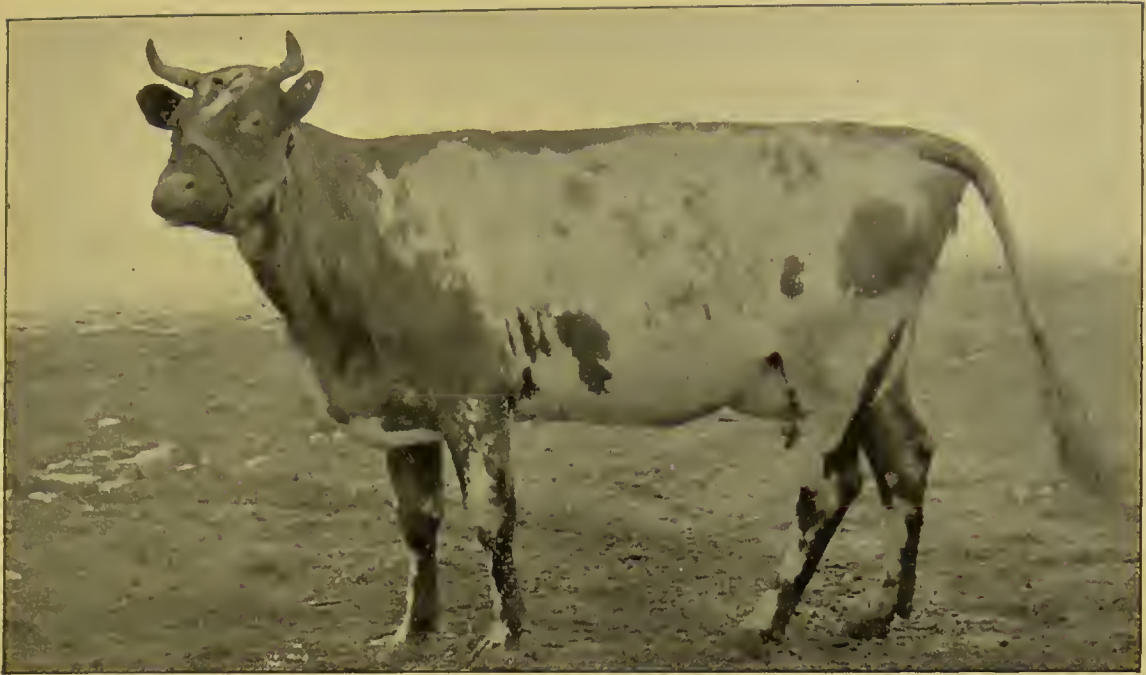


FIG. 43.—Durham. (Shorthorn.)



FIG. 44.—Devon.



FIG. 45.—Ayrshire.



FIG. 46.—Holstein-Friesian.



FIG. 47.—Brown Swiss grade.



FIG. 48.—Bretonne. (Naturally straight back, arched from cold.)



## ANALYSIS 42.

Fat . . . . .	4.09
Sugar . . . . .	4.32
Proteids . . . . .	4.04
Ash . . . . .	0.76
Total solids . . . . .	13.21
Water . . . . .	86.79
	<hr/> 100.00

The next cow (Fig. 45) is an Ayrshire, descended from a celebrated race in the south of Scotland dating back many centuries. Their constitutional vigor is great. They have great capacity for food, a good digestion, a temperament rather nervous, arising, probably, from an out-cross with the wild cattle of Chillingham. They are not so hardy as the Durham, but are very free from disease. The prevailing color is brownish red with white spots or flecks, though many of the best Ayrshires incline to a pure white or to a dark brown without white. This one is brown and white and is of medium size. Their horns turn upward and backward. They have large udders, and yield a large supply of milk, with the following analysis:

## ANALYSIS 43.

Fat . . . . .	3.89
Sugar . . . . .	4.41
Proteids . . . . .	4.01
Ash . . . . .	0.73
Total solids . . . . .	13.04
Water . . . . .	86.96
	<hr/> 100.00

The next cow (Fig. 46), which is of the thorough dairy type, is called the Holstein-Friesian. This cow represents the most perfect milking animal known, having every characteristic of a cow suitable for our purpose, but her milk is so light in its total solids that it is not so profitable as the other breeds. These cows are usually black and white in color, with black noses. The fat-globules of their milk are very small and evenly distributed, and the emulsion is perfect. These cows are usually large, weighing about 54.5 kilogrammes (about 1200 pounds). This special cow is now two years old and is not full grown. They are very domestic and gentle. They have large udders, and yield a larger quantity of milk than any other known breed, although the analysis shows it to be poorer in quality:

## ANALYSIS 44.

Fat . . . . .	2.88
Sugar . . . . .	4.33
Proteids . . . . .	3.99
Ash . . . . .	0.74
Total solids . . . . .	11.94
Water . . . . .	88.06
	<hr/> 100.00

The fifth cow (Fig. 47) is a Brown Swiss grade. The Swiss element is derived from the hardy race of the Alpine pastures. They are very vigorous, stand cold well, are docile and not easily frightened. They are rather under medium size, and are generally brown in color. The nose is black, with a mealy ring around it. They have a slightly dished face, and the udder is of medium size. They are very healthy, and yield a fair supply of milk of about the richness of the Devon, the analysis of which is as follows:



ANALYSIS 45.

Fat . . . . .	4.00
Sugar . . . . .	4.30
Proteids . . . . .	4 00
Ash . . . . .	0.76
Total solids . . . . .	13.06
Water . . . . .	86.94
	<hr/> 100.00

Finally, here is a little Bretonne cow (Fig. 48), known all over Europe as the "cow for the family." Cows of this breed have all the characteristics of the good domestic cow which I have already mentioned. They are blue-black or black and white in color, and have black noses, which are sometimes mottled and are rarely white. A distinguishing mark is that the mucous membrane of the mouth is always white, while that of some other breeds is black or gray and white. They are small, but have large udders, which produce a medium amount of milk, large, however, in proportion to their size. This special cow is cold from standing, and this is the reason that her back is arched.

I have mentioned the natural constitutional vigor of these cows, because certain breeds of cows in some localities do not appear to be able to resist the attacks of common diseases, such as tuberculosis. A notable illustration of this is represented by the Jerseys in America.

It is very important that certain precautions should be taken to prevent the use of cows which are affected with tuberculosis. It is probable that three per cent. of the cows whose milk is used for food are tuberculous. Where tuberculosis is developed to such a degree in the cow as to be dangerous to the consumer of the milk, the disease can usually be detected by a skilful veterinarian by means of the physical examination which is employed in cows. But, as it is a disputed question at present as to when the milk of a tuberculous cow becomes affected, it is wiser to adopt all measures of precaution known to science. Of these measures the one which is most efficacious in detecting even the incipient stages of tuberculosis is that which is used here on this farm.

The cows employed for the production of the primal milk-supply for the Milk-Laboratory have been subjected to the test for the diagnosis of tuberculosis. This test is known as the "tuberculin test." The method of making this test is as follows :

At about 9 o'clock P.M. the temperature of the cows is taken per rectum with an ordinary clinical thermometer. The temperature in healthy cows may vary from 37.7° C. to 39.7° C. (100° to 103½° F.), according to age, the weather, the condition of pregnancy, or the period of the day. As soon as the temperature of the individual cows is recorded, each one receives a subcutaneous injection of from 2 to 3 c.c. of a ten per cent. solution (1 c.c. of Koch's tuberculin to 9 c.c. of a one-half per cent. solution of carbolic acid in sterilized water), the proportion being adapted to the weight and vigor of the especial cow. This fluid, for convenience and uniformity, is introduced in the upper part of the right shoulder. After an interval of

eight hours—that is, at 5 A.M.—the temperature is again taken per rectum, and this procedure is repeated at intervals of three hours until 2 P.M.

At 5 A.M. the temperature should in healthy cows be slightly lower than that found on the previous evening. Subsequently the temperature should not rise above that of the first record at 9 P.M. No rise in temperature occurs in a cow which is free from any tubercular affection. Where the temperature rises to  $41.1^{\circ}$  to  $42.2^{\circ}$  C. ( $106^{\circ}$  to  $108^{\circ}$  F.), it indicates disease and marks the cow as tuberculous, though even a lower reading sometimes marks the presence of the disease in cows whose normal temperature was low.

No water should be given to the cow during the period of the experiment, because it is found that the temperature, as soon as the water reaches the stomach, is lowered to or nearly to normal, according to the amount and temperature of the water.

This test is a very delicate one, and records the presence or absence of the slightest tuberculous infection, even if the disease has not previously affected the cow in any way which can be detected by an ordinary physical examination.

At the point of inoculation there are marked tenderness and heat in cows that are tuberculous for many hours after the conclusion of the test, while in cows that are healthy the skin is not irritated by the use of the syringe.

I have now explained to you what I consider to be a very important part in accomplishing a successful substitute feeding. I shall at my next lecture describe the characteristics of the milk which is brought from the herd to the Laboratory, where it is modified.

## LECTURE IX.

## III. INDIRECT SUBSTITUTE FEEDING.—(Continued.)

## GENERAL REMARKS ON SUBSTITUTE FEEDING—COMPARISON OF WOMAN'S AND COW'S MILK—MILK-LABORATORIES.

IN my last lecture I explained to you at the farm the methods employed for obtaining a primal milk-supply especially adapted to infant feeding, and the types of cows which experience has proved to be the best for this purpose. You will now understand that where human milk that is suited to the individual infant cannot be obtained, or if obtained cannot be regulated by modification, it is desirable to substitute for it the combination of elements which such a human milk represents. To accomplish this we must have materials which, while closely resembling the elements of normal human milk, are easily obtained.

Physiological experiments on the mammary gland show that the albumin of the milk is not directly an exudation from the lymph-vessels supplying the mammary gland, but that it is actually modified in the gland itself. We thus see that the mammary gland, besides being an elaborator for infant nutrition, is also a modifier. This suggests to us that the modification of milk is not contrary to nature's method of preparing food for infants. Following, therefore, nature closely, we have learned that the proper modification of absolutely pure and fresh milk is the vital principle which should underlie our efforts to perfect a substitute food. I have already shown you the best method of obtaining a stable and perfectly pure cow's milk. When this milk is obtained, how shall it best be modified?

In addition to the general principles which I have enunciated concerning maternal feeding, and which apply equally to substitute feeding, there are certain principles connected especially with substitute feeding to which I desire to call your attention before taking you to the Milk-Laboratory, in order that you may use the Laboratory to the best advantage.

The infant at the breast receives for its nutriment a fluid which is fresh, sterile, neutral, or faintly alkaline, which has a temperature of  $36.7^{\circ}$ – $37.8^{\circ}$  C. ( $98^{\circ}$ – $100^{\circ}$  F.), furnished in an amount proportionate to the age and size of the consumer. It is this fluid which we have to copy in every possible detail when we undertake to prepare a substitute food. We should also consider as foreign matter, to be carefully avoided, any element which we know is not to be found in the milk we are copying. Thus, and thus only, can we arrive at the proper solution of this intricate question of substitute feeding.

The analyses of human milk, which I have shown you in a previous



lecture (Lecture VII., page 179), teach us that there is a great capacity in different infants to assimilate a variety of proportions of the same nutritive elements. In all probability the infant needs a variety in its food to somewhat the same extent as does the adult. In order, therefore, to copy nature closely, we must have some means of preparing a food not only for the many but for the individual, and when introducing new methods for preparing a substitute food we must recognize the necessity for providing for many prescription possibilities. In this busy age of scientific rational medicine physicians all over the world demand, first, means of saving time, and second, exact methods of work, which in themselves soon become time-savers. In every branch of our art the tendency is growing year by year to systematize the detailed and laborious work of the individual for the common practical use of the profession at large. I have long felt that in some way the subject of substitute feeding should be reduced to a more exact system, and that an effort should be made to rescue this important branch of pediatrics from the pretensions of the owners of proprietary foods and the hands of ignorant nurses. With this end in view, I have given my professional assistance to the establishment of a system of milk-laboratories where the materials used shall be clean, sterile, and exact in their percentages. These laboratories have been placed under the control of educated, intelligent men in whom we have the same confidence that we have conceded to the pharmacist, and we can write directions for infants' foods and send them to these laboratories just as, in the treatment of disease, we write our prescriptions for the division of one drug or the combination of several. As the pharmacist has nothing to do with the various methods of treating disease, so the milk-modifier is simply required to carry out the directions and ideas of the physician. No special school of medicine need be represented. No special method of feeding need be undertaken. An opportunity has, however, for the first time in the history of medicine, been presented for the physician to carry out his own methods, and these methods for the first time to be judged on a fair basis. In this way only can each clinical observer, when lacking in success, be sure that it is the fault of the food he is giving, and not because the food has varied from what he supposed he had ordered.

I have come to the conclusion that even slight changes in the percentages of the three important elements of milk of which we have most accurate knowledge—namely, the fat, the sugar, and the proteids—are of real value in the management of the digestion and nutrition of the infant, and that these changes are often necessary day by day as well as month by month. With this fact impressed upon us, we can well see that no one mixture will in all cases prove successful, but that a great variety in the percentages of the different elements of the milk will be needed in substitute feeding just as they already exist in maternal feeding. This explains the diversity of results obtained in the past with the same food by different practitioners.

The means for prescribing a diversity in the elements of milk, according

to the idiosyncrasy of the digestion we are dealing with, is supplied by a milk-laboratory equipped with special machinery and controlled by educated milk-modifiers. From what I have previously said, you will understand that purity of the original material is the first object to be attained. This milk should be obtained from cows bred, fed, and cared for in the manner which was described in the last lecture, and, in order to insure absolute uniformity in the methods which I then explained to you, untiring vigilance must be used in the supervision of the farm, cows, and milk-house, and in the transportation of the milk from the farm to the laboratory. It is also necessary that the cows should be under the medical supervision of a skilled veterinary surgeon. These are all questions which to my mind have been definitely decided, but which now need time and attention devoted to them to insure their being systematically carried out. As in all other advances which are made in practical medicine, so also in this one it is well to adopt at once a high standard of work and to demand everything that can in any way tend to perfection. We may not always be successful in carrying out all the details, but until we are so perfection will not be arrived at. Bear in mind, then, the chain of facts which I have endeavored to simplify and explain to you, and understand that each link of that chain is of vital importance, because, if broken, the value of the whole chain may be lost. One end of this chain is at the milk-farm. We have followed it from the stall to the milk-house, and from the milk-house to the laboratory, and we must now so manage the continuation of this chain that it shall come unbroken and intact to the infant consumer.

APPARATUS FOR FEEDING.—Human ingenuity has not yet been able to devise anything which approaches the perfection of nature's apparatus for feeding, and the best that we can do to offset this complex mechanism is to adopt that which is exactly the reverse,—namely, an apparatus of absolute simplicity,—and thus combat the tendency to fermentation by preventing, through perfect cleanliness, the apparatus from becoming a source of fermentation. To accomplish this object the receptacle from which the infant is to be fed should be made of glass, in the form which will enable it to be most easily cleansed, and, as in the future the question of transportation will undoubtedly be a grave one, the receptacle should be such that it can be adapted to transit and not easily broken. For this purpose, what are practically test-tubes fulfil these indications best. These tubes have open mouths larger than those usually provided in the ordinary nursing-bottle, and, having no angles, are readily cleansed. The artificial receptacle is not self-regulating, and hence we must determine the amount of food in bulk which nature provides for the average infant at different ages, and from these average figures deduce the proper amount for the especial infant. The feeding-tubes are graduated for the more important periods of growth, for the purpose of continually impressing upon the mother and nurse what the physician often has the opportunity of telling them only at the beginning of the nursing period,—namely, that the error is in giving too much food rather than too

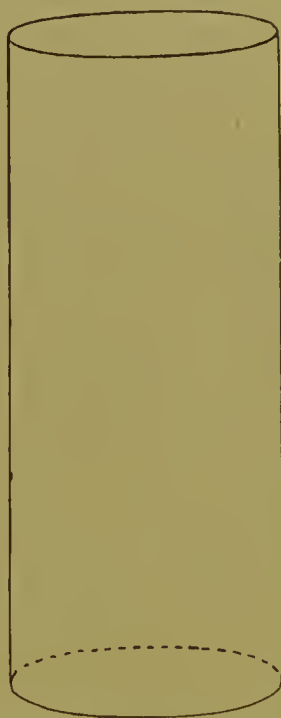
little, an error, also, which naturally results when, as is commonly the case, the usual eight-ounce nursing-bottle is provided as the receptacle at the very beginning of infantile life.

I have found that I can easily convince most mothers of the mistaken zeal of nurses who advocate giving the young infant large amounts of food, by showing them the size of the infant's stomach at birth and comparing this small tube which corresponds to the stomach's capacity with an eight-ounce nursing-bottle.

FIG. 49.



Stomach from infant five days old ; capacity 25 c.c.  
(Natural size.)



Glass cylinder, capacity 25 c.c.  
(Natural size.)

I shall presently show you these tubes at the Laboratory, and I speak of them here merely to impress upon you the great importance of carefully attending to the smallest details in substitute feeding.

**NIPPLES.**—A nipple made of fine soft rubber adapted to the especial infant as to its size and the holes for the milk is substituted for the maternal nipple. These rubber nipples should be large enough to be turned inside out and carefully cleansed after each feeding. They should be boiled after being used, and kept in cold water with a little soda in it. They should be renewed frequently, the oftener the better: preferably a new one should replace the old one three times a week. It will be found that the rubber nipple has to be adapted to the taste of the especial infant, and that it often has to be changed as to its size, texture, and holes before the infant is satisfied with it and sucks satisfactorily from it.

**INTERVALS OF FEEDING.**—I have already shown you in this table (Table 42, page 182) the intervals of feeding which should be, as a rule, adhered to in maternal nursing. These intervals should also be adopted in substitute feeding, but the amount of food to be given now becomes a prominent feature in the division of the total amount of food which it is proper to



give in the twenty-four hours, according to the age and development of the individual infant.

AMOUNT AT EACH FEEDING.—The infant's weight and its gastric capacity quite frequently do not correspond. Yet there seems to be no doubt that the weight is a condition to which marked consideration should be given when we are attempting to determine so difficult a question as the proper amount of food to be given at each meal in the early months of life. The amount to be given at each feeding must be carefully regulated according to the gastric capacity, and I have stated in a previous lecture (Lecture IV., page 80) what the gastric capacity is at different ages.

I have arranged some tables (Tables 57 and 58) to show how the intervals of feeding and the amount of food to be given should correspond to the gastric capacity at different periods of the first year. I think that they will prove useful to you when you have to decide on the amount of food which it will be safe and wise to begin with in your cases. It is so important to avoid stretching so easily distensible an organ as the stomach that it is wiser to give too little rather than too much food in the early days of life.

TABLE 57.

*General Rules for Feeding during the First Year.*

*The day feedings are supposed to begin with the 6 A.M. feeding and to end with the 10 P.M. feeding.*

Age.	Intervals, hours.	Number of Feedings in 24 hours.	Number of Night Feedings.	Amount at each Feeding.		Total Amount in 24 hours.	
				Cubic Centimetres.	Ounces.	Cubic Centimetres.	Ounces.
1 week . .	2	10	1	30	1	300	10
2 weeks . .	2	10	1	45	1½	450	15
4 weeks . .	2	9	1	75	2½	675	22½
6 weeks . .	2½	8	1	90	3	720	24
8 weeks . .	2½	8	1	100	3½	840	28
3 months . .	2½	7	0	120	4	840	28
4 months . .	2½	7	0	135	4½	945	31½
5 months . .	3	6	0	165	5½	990	33
6 months . .	3	6	0	175	5¾	1035	34½
7 months . .	3	6	0	190	6¼	1125	37½
8 months . .	3	6	0	210	7	1260	42
9 months . .	3	6	0	210	7	1260	42
10 months . .	3	5	0	255	8½	1275	42½
11 months . .	3	5	0	265	8¾	1312	43¼
12 months . .	3	5	0	270	9	1350	45

The first month being the most critical period for the infant's nutrition, as it is the time when the equilibrium of its metabolism is being established and its chance for life is least, especial interest should be attached to the series of careful investigations made at the Children's Hospital in St. Petersburg by Ssnitkin to determine the amount of food which should be given in the first thirty days of life. As the result of these investigations he deduces the rule, "the greater the weight the greater the gastric capacity." Ssnitkin's general results (Table 58) show that *one one-hundredth of the initial weight*

should be taken as the figure with which to begin the computation, and to this should be added one gramme for each day of life.

TABLE 58.

*Illustration of Ssnitkin's Rule to aid in adjusting the Food to especially difficult Cases in the first Thirty Days.*

Initial Weight.	Amount at each Feeding.		
	Early Days.	At 15 Days.	At 30 Days.
3000 grammes . . .	30 grammes. (About 1 ounce.)	30 + 15 = 45 grammes. (About 1½ ounces.)	30 + 30 = 60 grammes. (About 2 ounces.)
4500 grammes . . .	45 grammes. (About 1½ ounces.)	45 + 15 = 60 grammes. (About 2 ounces.)	45 + 30 = 75 grammes. (About 2½ ounces.)
6000 grammes . . .	60 grammes. (About 2 ounces.)	60 + 15 = 75 grammes. (About 2½ ounces.)	60 + 30 = 90 grammes. (About 3 ounces.)

It is wiser always to accomplish first the proper digestion of the food, even if there is no gain in weight, and then, when once the infant is digesting well, to increase the amount of the percentages of the different elements. At times when the infant is digesting well, and even gaining, it will suddenly cry so hard and with such evident hunger that an immediate increase in the amount of its food is not only indicated but demanded, no matter what its age or weight. In these cases the stomach has probably grown rapidly and out of its normal proportion to the age and size of the child, and a larger supply of food is what is needed.

Our clinical experience proves to us that the average infant in the early months of its life does not digest unmodified cow's milk. The exceptional instances where it is tolerated have their counterparts in the success of many other foods diverse in their composition, and only serve to prove that the human digestion can at times be tampered with without much apparent injury, and to emphasize the general rule that the chemistry of the food which will produce the best average result should be the chemistry of human milk. Cow's milk, therefore, should be carefully compared with the standard human milk in order that we should know how nearly it resembles it. This table (Table 59) is a comparison of the average human milk and the average cow's milk, the figures representing the later and more reliable analyses :

TABLE 59.

	Woman's Milk directly from the Breast.	Cow's Milk as ordinarily received about 24 hours old.
Reaction . . . . .	Slightly alkaline.	Slightly acid.
Water . . . . .	87-88	86-87
Total solids . . . . .	13-12	14-13
Fat . . . . .	4.00	4.00
Milk-sugar . . . . .	7.00	4.50
Proteids . . . . .	1.50	4.00
Coagulable proteids . .	Small proportionately.	Large proportionately.
Coagulation of proteids by acetic acid. . . .	Not perceptible in test-tube.	Marked in test-tube; greatest with pure milk; less with milk diluted with water, and when 1 to 5 is not perceptible.
Ash . . . . .	0.20	0.7

From this comparison we at once see that human milk and cow's milk differ as markedly from each other in their chemistry as they do in their clinical results as foods ; and, as practically we must use cow's milk in substitute feeding, our wisest course is to modify it until we have approached the chemistry of human milk as closely as possible.

Before speaking of the various modifications of cow's milk which it is necessary to make in order that it may correspond to human milk, it will be well to say a few words about its properties as represented in the table (Table 59, page 235).

REACTION.—The reaction is stated to be slightly acid ; and this is the case whether it has stood twenty-four hours with ordinary care or whether it is tested directly from the udder. This I have determined by direct experiment : so that practically the same amount of modification will be correct for the first twenty-four or thirty-six hours, so far as the reaction is concerned.

As it is wise in preparing a mixture for substitute feeding to make such a mixture approach as closely as possible in both taste and reaction to woman's milk, Harrington's experiments made at my request (Table 60) with lime water and ordinary cow's milk twenty-four hours old are important. Lime water was the alkali used in these experiments because it is the most simple adjuvant which we can use for making cow's milk alkaline, the amount of lime contained in it being so small that its addition in even considerable quantity does not materially alter the amount of the total mineral matter. As small an amount as one-sixteenth part, when added to ordinary milk, will render it alkaline, so that for making an acid milk correspond in its reaction to woman's milk, lime water is of great value, as it apparently does not produce any other changes in the milk. In addition to this, the taste of a mixture which is made from ordinary cow's milk, so as to correspond to the composition of woman's milk, is strikingly like that of woman's milk if it contain one-sixteenth part of lime water.

Harrington has made an estimate by actual experiment of the amount of lime water which is needed to produce an alkalinity in a mixture such as I have just mentioned which would correspond to the alkalinity of human milk. This table (Table 60) shows the results of his experiments.

TABLE 60.

Amount of Lime Water in Mixture.	Reaction.
25 per cent. . . . .	Strongly alkaline.
12.5 per cent. . . . .	Still strongly alkaline.
6.25 per cent. . . . .	Slightly but distinctly alkaline, and corresponding to woman's milk.

It must be remembered that these proportions of lime water are those required for ordinary milk twenty-four hours old, a much smaller proportion being needed to produce the same results when the milk is treated with the care which I showed you was employed at the farm connected with the Milk-Laboratory.



**WATER.**—There is about one per cent. less of *water* in cow's milk than in human milk. Chemical analyses invariably show so large an amount of water in human milk that it is evident that the infant is intended to take, and can best assimilate, a very dilute food. We must bear this fact in mind in preparing a substitute food, as the precaution of supplying a thoroughly diluted food is of extreme importance in managing the infant's feeding both in health and in disease.

**TOTAL SOLIDS.**—There is about one per cent. more of *total solids* in cow's milk than in human milk. These solids in the milk are held partly in solution, partly in semi-solution, and partly in suspension.

**FAT.**—The percentage of *fat* in the average cow's milk and in the average human milk is the same. The glycerides of the fatty acids composing the fat in both cow's milk and human milk have been determined, yet our chemical and clinical knowledge of the nutritive value and digestibility of these, separately or collectively, has not arrived at a point where we can practically make use of this knowledge, and we therefore direct our attention to regulating in a milk modification the percentage of the fat as a whole.

Under this microscope you will see (Photo-micrograph, Fig. 61, page 259) a thin layer of milk which is represented by a transparent medium permeated with small globules of fat. This fat is simply held in suspension, which enables us to separate it easily by mechanical means. It is, in fact, in a condition which marks the milk as an emulsion.

**SUGAR.**—The *sugar* which is present in the milk of all mammals is of the variety called *milk-sugar*, or *lactose*. It is a simple and uniform element to deal with. Its percentage in cow's milk is 4.5, and in woman's milk 7. It is held in solution in the milk.

Regarding the kind of sugar which should be used in making up a substitute food, we have certain questions to consider which would seem to be important. Cane-sugar has been, and still is, a favorite form with which to regulate this part of the solid constituents of the food. The reasons given for using it have been its preservative qualities, as seen in the manufacture of condensed milk, and the theory that it is not liable to set up excessive so-called lactic acid fermentation, with its consequent disturbance of digestion, as has been supposed to be the case with milk-sugar. Cane-sugar in a concentrated form, as it is found in condensed milk, seems to act as a preservative. But when it is diluted, as in its administration to the infant, cane-sugar ferments very readily, and in this respect has no advantage over milk-sugar. Reasoning from analogy, we should say that as milk-sugar is the only form of sugar found in the milk of mammals, it is there for some good purpose, and that it is needed for the accomplishment of some process which takes place after the food has been swallowed. Both cane-sugar and milk-sugar are converted into glucose in the intestine. There seems, however, to be some difference in the degree to which they can be used for purposes of nutrition before they are converted into glucose. So far as is known, whether in plants or in animals, cane-sugar is merely a reserve, and

cannot be used directly for nutrition. Milk-sugar, on the other hand, is probably not merely a reserve, but may possibly be utilized in the economy also for nutrition. Thus, Bernard has shown that seven grains of milk-sugar dissolved in an ounce of water could be injected under the skin of a rabbit without the subsequent appearance of sugar in the urine, while under the same conditions and in the same amount cane-sugar was found to be eliminated as foreign matter by the kidneys.

Milk-sugar undergoes no direct alcoholic fermentation, but it changes readily to lactic (possibly acetic) acid in the presence of nitrogenous ferments, while cane-sugar easily undergoes alcoholic fermentation, but changes to lactic acid less readily than milk-sugar. Cane-sugar, moreover, takes on the butyric acid fermentation more readily than does milk-sugar. The *bacillus lactis aërogenes* (Escherich) is present in normal digestion, and acts on the milk-sugar to produce an organic acid which drives out the more noxious forms of bacteria, which by their presence would interfere with normal digestion. When milk-sugar is converted into glucose, we physiologically have a gradual conversion into lactic acid, which may aid in the digestion of the albuminoids, thus giving us a very valuable addition to the means at our command for rendering modified cow's milk digestible.

Jeffries says, in reference to the different actions of the various kinds of sugar in the digestive tract, that it is important to note that starch, dextrin, inulin, cane-sugar, and dextrose afford material for the butyric acid fermentation, while milk-sugar does this only after completed hydration.

Escherich, in speaking of Brieger's bacillus, says, "Milk is coagulated with sour reaction first after several days (eight to ten) at the body temperature. With exclusion of air this bacillus cannot grow either in milk or milk-sugar solution, but will in grape-sugar."

We thus see that the milk-sugar offers less danger of the butyric acid ferment, which we know makes much trouble at times in the body, and that under certain conditions of the intestine it should be exempt from the assaults of Brieger's bacillus.

When we consider that by means of heat we can practically put an end to the lactic acid fermentation, which may have begun to act upon the milk before it enters the stomach, it would seem that we are justified, on both physiological and bacteriological grounds, in using the same animal sugar in substitute feeding that is found in the infant's natural food, instead of introducing a vegetable sugar, which in milk is a foreign element.

The dangers from lactic acid are, at any rate, much exaggerated by writers on this subject.

PROTEIDS.—The proteids of normal human milk have quite a wide range in their variation; still, it is now well recognized that their average normal percentage is very much below that of cow's milk. Assuming that the percentage of proteids in human milk is 1.5, or between 1 and 2, it can be stated that the relation of the percentage of the proteids in cow's milk and in human milk is as 4 to 1.5.





When a few drops of mercuric nitrate solution were added to woman's milk and to cow's milk which had been diluted 1 to 5, as is represented in test-tube 11 in the table (Table 61), a fine coagulum was produced in the woman's milk, and a still finer one in the cow's milk.

There was found to be practically no difference as to the rapidity of the coagulation of the different mixtures whether the milk was not heated or was heated to 100° C. (212° F.).

Cow's milk taken directly from the udder was found to coagulate in just as large curds as when twenty-four hours old. It was found that there was practically no difference in the coagulation of raw, boiled, or steamed milk ; also that the size of the curd depends on the dilution of the proteids, rather than on any especial property belonging to the substance with which the dilution is made. With lime water the result was the same as with water in equal amount, and barley water shows only a fractional difference from the results obtained with plain water.

ATTENUANTS.—In order to ascertain if the statement is correct which is so often made, that “attenuants act mechanically by getting between the particles of coagulum during coagulation and thus preventing their running together and forming a large compact mass,” I have experimented as follows with various substances containing different percentages of starch :

In each of six test-tubes of equal calibre, and containing 5 c.c. of hot water, 10 c.c. of milk were placed. In test-tubes 1, 2, 3, 4, 5, and 6 were added equal portions respectively of some starchy foods, cracker-crumbs, and bread-crumbs. The proteids were then coagulated as before with acetic acid, and the results were as seen in this table (Table 62) :

TABLE 62.

Test-tube.	Mixture.	Coagulum.
1.	Hot water and milk . . . . .	Finest curd of all.
2.	Hot water and milk and starchy food . . . . .	Not so fine as 1.
3.	Hot water and milk and starchy food . . . . .	About like 2.
4.	Hot water and milk and starchy food . . . . .	Not so fine as 2 or 3.
5.	Hot water and milk and cracker-crumbs . . . . .	Not so fine as 4.
6.	Hot water and milk and bread-crumbs . . . . .	Not so fine as 5.

There is no doubt that where no attenuant was added the curd looked decidedly finer, while where attenuants were used there was not a great deal of difference in the result obtained with the substances employed, except the possibly rather larger curd according as the attenuant contained a larger percentage of starch.

We may conclude, then, until something more definite is known concerning this rather theoretical method of treating the curd, that dilution with plain water is the most practical and efficient means at our command.

As the predigestion of the proteids is frequently recommended by physicians when the infant's digestion is normal as well as when it is weakened, it is well to say a few words about this predigestion in connection with substitute feeding.

Peptonized milk is cow's milk with its proteids partially or entirely pre-digested by means of the extract of pancreas and soda. There is no doubt that the proteids of cow's milk are at times a source of trouble to the infant's digestion, and that under certain circumstances they can with great benefit be treated by predigesting them for a time, and allowing a stomach which otherwise digests well to rest and recover its entire digestive power. It is of use also where a decided idiosyncrasy of the individual precludes the digestion of these constituents of the milk. In many cases the indigestion is attributed to a lack of power to digest proteids at all, while in fact the stomach is simply rebelling against an amount of proteids above the standard percentage, or against some other constituent. It would seem that, for the average infant, this predigesting of the proteids is contrary to nature's teaching. There are certain natural functions which should be allowed to act as they do on human milk, and it seems irrational and contrary to the laws of physiology not to encourage all the functions to act naturally, instead of forestalling their action and allowing them to fall into disuse and thus to be weakened. The infant's stomach is intended to digest proteids, and not to have the proteids digested for it. Clinically, also, the use of peptonized milk supports this view, for, so far as I know, no very brilliant results have been obtained from its use, except where the infant's digestion has been in an abnormal condition and one which has called for some decided relief from the proteid elements of milk. Peptonized milk, therefore, as a food for young infants is one which consists of too large an amount of digested proteids, too little sugar, and a very large over-proportion of mineral matter.

ASH.—The constituents of the ash of cow's milk have been analyzed with comparative care and success. I have already, in speaking of the differences which exist between cow's milk and woman's milk, stated the differences which exist in their constituents and the elemental percentages of those constituents. This question of the percentage of the ash practically does not enter into the modification of milk at the laboratory, as our knowledge has not yet advanced to that point where we can make use of what we know of these differences.

There are a few other questions concerning the composition of cow's milk in relation to its proper modification for substitute feeding which it will be well to speak of here.

Cow's milk, besides the elements which I have just spoken of and which I have represented in this table (Table 59, page 235), is supposed to contain a small portion of fibrinogen held in suspension. I have adopted the terms fibrinogen and caseinogen as recommended by Haliburton. They represent their respective elements as they actually exist in the milk before any change has taken place in them. After the milk has been drawn from the udder we have certain elements which we call *casein*, resulting from the *caseinogen*, and *fibrin*, resulting from the *fibrinogen*.

Cow's milk is also supposed to contain urea and citric acid.



In substitute feeding, the addition to modified cow's milk of some substance, such as starch in various forms, is so frequently recommended that I think it will be well to state my opinion of this practice.

This brings us to the consideration whether starch should be made a part of an infant's food. Physiologically, we know that during the first ten or twelve months of life the function of converting starch into sugar is in the process of development. It is true that a partial conversion of the starch can be performed at quite an early age, and, in exceptional cases, to a much greater extent than by the average infant. It is rational to suppose that when a function is being developed it should not be taxed with a trial of the use which will later be demanded of it. That is, a function develops more perfectly if its power is not exerted too early. With these facts before us, and simply recognizing that the best known food for infants, woman's milk, does not, under any circumstances, contain starch, I believe that starch should not form a part of the infant's food in the early months of its life.

The question whether milk should be boiled or steamed is one which is not of much significance, and can be settled according to the fancy of the individual practitioner, a greater or less destruction of the bacteria contained in the milk taking place according to the degree of heat to which it is submitted. My own experiments in comparing steamed with boiled milk show that the odor and taste of boiled milk are present when milk is steamed, but to a much less degree than in boiled milk; also that while a thick scum is formed on milk boiled for twenty minutes, which is tenacious and does not disappear on shaking, only a very thin scum forms on milk steamed for twenty minutes, and that this is not tenacious and almost entirely disappears on shaking.

**BACTERIOLOGY.**—A few matters concerning the bacteriology of cow's milk can best be considered in connection with the subject of substitute feeding. Respecting this question Dr. J. A. Jeffries very aptly remarks "that it is a curious fact that, while older people are chiefly fed on sterilized food,—that is, cooked food,—infants are fed on food peculiarly adapted by its composition and fluid state to offer a home for bacteria." In some experiments made by Jeffries agar-agar cultures were made before and after the different fluids were sterilized, and the colonies of bacteria were counted. His results coincide with those of previous experimenters,—namely, that steaming for fifteen minutes is sufficient to kill the developed bacteria, while a second steaming is necessary for complete sterilization. Out of one hundred and twenty lots of milk steamed but once, all but four or five showed distinct signs of change within a month, while the majority of those steamed twice did not change at all.

Jeffries's experiments also show that spores develop slowly, and, indeed, rarely form, in milk, which, as he says, is an excellent medium for growth, while spore-formation among bacteria, like seeding among higher plants, is a phenomenon of impaired growth. He also explains the preservation of



some of the milk steamed but once by the absence of any enduring spores from the start. In an article of very great interest and value to the practising physician "On the Bacteria of the Alimentary Canal," Jeffries has reviewed, at my request, the work done by the various bacteriologists:

"Miller, De Barry, and Escherich have shown that living bacteria are to be found in the stomachs of men and animals, and the former author has also clearly proved that bacteria can pass through the stomach into the intestines and live for a considerable time. . . . Of the morphology and biology of the forms found in the stomach little is known. The field is a new one, and the species have not been sufficiently described to enable others to recognize them with certainty. Miller has found five kinds which give off carbonic dioxide and hydrogen gas, lactic, acetic, and butyric acids being formed. . . . Of the flora of the intestines much more is known than of that of the stomach. The researches of Brieger, Vignal, Stahl, and Escherich have now proved that a large number of species may occur in the fæces. Brieger isolated two new kinds: one a micrococcus, which turns grape- or cane-sugar into ethylalcohol, with a trace of acetic acid; the other the well-known Brieger's bacillus. This species occurs in the fæces in vast numbers, ferments sugar, and decomposes albumins. Vignal isolated ten species from the fæces, six of these also being found in the mouth. Of these some produced acid fermentations and gas, but unfortunately they were not sufficiently studied to show their effects on digestion. . . . Escherich studied especially the fæces of infants, and found a large number of kinds of bacilli, among them a small bacillus capable of converting milk-sugar into lactic acid, carbonic dioxide and hydrogen gas being evolved, either in the presence or absence of air, a facultative anaërobic species, his *bacillus lactis aërogenes*. Escherich established, by the examination of a large series of cases, the fact that the kinds occurring in the fæces vary with the food,—that is, the intestinal contents. . . . Starting at birth with the sterile meconium, consisting of mucus, epithelium, and the like, infection by the mouth and rectum quickly occurs, and in a short time almost any form may be found, but chiefly such putrefying forms as *proteus vulgaris*.

"With the suckling of the infant and the substitution of the refuse of the milk and secretion of the digestive tract for the meconium, a sharp transition occurs. Instead of the generally distributed forms causing decomposition, only two kinds are regularly found, *bacillus lactis aërogenes* and Brieger's bacillus; the first chiefly in the upper parts of the intestine, the second in the lower parts. Passing on to the period of mixed diet, quite a number of forms appear, among them the *streptococcus coli gracilis*, the *putrefying green fluorescing*, a *tetrad coccus*, and *several kinds of yeast*. This brings us to the pith of the subject: Why are the flora so limited in the milk-eating infants and so diverse in others? What drives the forms found in the meconium out? That they can live there is clear, as shown by their presence the day before. Again, what prevents forms so common with meat diet from gaining a footing? It is not the milk alone, for milk

is an almost universal food for bacteria, and all the kinds found in the intestines thrive in it.

“According to Escherich, the *bacillus lactis aërogenes* and the milk diet keep out the other forms.

“Formerly,” continues Jeffries, “even before the action of ferments and putrefactive processes were clearly understood, the significance of this question was seen. The chyme is a mass admirably adapted for putrefaction or fermentation, yet ordinarily but little of either occurs. It is an alkaline or, as in the milk-fed, acid mixture rich in albumins, fats, and the starch group, amply provided with water and warmth. Such a mixture outside the body at an equal temperature would quickly decompose. It was generally held that some preservative action was exerted by the digestive juices: Bidder’s and Schmidt’s dogs with biliary fistulæ were supposed to explain the whole. These dogs, deprived of their bile, became emaciated, and suffered from diarrhœa and decomposition of the intestinal contents. Thus it seemed clear that in the absence of the bile decomposition occurred,—that is, that the bile was a powerful germicide or germ-inhibitor. During the last few years, however, different results have been obtained in cases of biliary fistula. Rohmann’s dogs did not suffer from diarrhœa or putrefaction in the intestines, hence it is clear that the bile is not the cause of prevention. The diarrhœa, if present, is due to the large amount of fat passed on to the lower intestines.

“Maly and Emich ascribed value to the bile acids, especially the taurocholic, basing their results on crude methods; and Lindenberger, really leaving the subject, attributed the action to the organic acids in combination with the bile.

“All this argument and belief in the decided germicidal action of the bile occurred in the face of the well-known fact that bile itself will decompose.

“From a bacteriological stand-point, Miller has shown that a ten per cent. solution of bile, if anything, favors growth. Macfadyen has studied bile, bile salts, and bile acids in varying strengths. The only positive results were got with the acids; these arrested the development of bacteria if sufficiently strong, especially taurocholic acid. Neither acid had much effect, and least of all on the forms causing putrefaction. *Proteus vulgaris* was only arrested by a strength of from one to two per cent. The pathogenic forms were arrested by a much smaller quantity, from one to one-half per mille.

“It is thus clear that other causes must be sought for. One of these is to be found in the lack of oxygen in the intestines, as pointed out by Escherich and strangely forgotten by others. There is certainly very little free oxygen in the chyme, if any; not only is it scarce in the food at the start, but is taken up by the chemical changes during digestion, and also by the intestines. This clearly must be a potent factor, for the majority of bacteria require a fair supply. Accordingly, many bacteria are found in the fæces which will grow in the air, as shortly stated by Macfadyen, and the mass of those isolated in the air are able to grow without it.



"This apparent contradiction, the absence of oxygen in the intestines, and the presence of both aërobic and anaërobic bacteria, is probably explained by the ability of the aërobic kinds to draw oxygen from oxyhæmoglobin. They thus breathe through the intestines, as it were, when in close contact with the walls, while the anaërobic kinds live in the mass of the chyme, and do not, so far as we know, reduce oxyhæmoglobin.

"Escherich, though he points out the absence of oxygen, does not seem to give it full value, or rather forgets the subject in treating of the action of his *lactic acid bacillus*. As before stated, this form is regularly found in great numbers in the upper part of the intestines of milk-fed children. Here it converts a considerable part of the milk-sugar into lactic acid, and thus prevents the other forms from growing,—most forms being susceptible to an acid reaction, and especially to the organic acids. The action of salicylic acid is known to all, and recent experiments, of which Macfadyen's (the last) are the best, show acetic, butyric, and lactic acids to be efficient germ-inhibitors in strengths of from one to one-half mille according to the species.

"In milk-fed infants another point is the comparative inability of bacteria to attack casein, so that the bacteria are literally starved.

"We may therefore conclude that the bile acids, lack of oxygen, lack of suitable albumins, and the presence of organic acids are the causes of immunity from the putrefying and fermenting kinds of bacteria to which we are exposed. Certain forms are probably limited by the lack of water,—that is, of a fluid state,—doing poorly if unable to swim freely about. It must not, however, be supposed that bacteria are scarce in the intestines; on the contrary, they form a large part of the dry substance of the fæces.

"The ferments act by the production of various acids, chiefly derived from the milk-sugar. In small amounts, as in the case of the *bacillus lactis aërogenes*, the acid seems to be of benefit, and certainly does no harm, as it regularly occurs in healthy breast-fed infants. In large amounts, however, it must tend to over-acidify the contents of the intestines and interfere with the action of the digestive fluids."

**MILK-LABORATORY.**—I shall refer again to this analysis (Analysis 40, page 218) of the average milk of herds of cows when I am explaining the method by which those who are too far away from medical centres to make use of milk-laboratories may be enabled to modify milk with reasonable exactness from herds of common cows. Where, however, modification at the laboratory is used, according to the methods which I have described to you, constant special examinations of the milk-supply from the particular herd employed are necessary.

I shall first describe the modification of the milk by means of the mechanism of the laboratory, and later speak of the more inexact methods, which may be designated as "Home Modification" (Home Modification, page 276).

As milk is one of the best means for the cultivation of bacteria, the



laboratory should be situated in a healthy locality. It should be as free as possible from contaminating influences, should be kept absolutely clean, and every aseptic precaution against the harboring or development of pathogenic organisms should be taken.

From the moment that the milk is delivered from the farm at a temperature of about  $4.4^{\circ}\text{C}$ . ( $40^{\circ}\text{F}$ .) it should be watched over and cared for with scientific accuracy during the whole process of the modification which it undergoes in the laboratory. The milk-rooms should be cool and free from dust, and isolated, so far as possible, from other parts of the laboratory.

FIG. 50.



Milk-room.

There should also be an entirely separate room where the returned packages and all articles received from the homes of the consumers should be directly brought from the street or wagons, and where these articles can be immediately sterilized in apparatus reserved for this purpose.

The modifying materials used in the laboratory should be carefully kept for use in glass vessels, and at a temperature of about  $4.4^{\circ}\text{C}$ . ( $40^{\circ}\text{F}$ .), to prevent the growth of bacteria. The reason for this is that milk modified from materials free from bacteria is better for the infant than milk in which the bacteria have been destroyed by heat. Therefore the utmost care is necessary in all parts of the process and in every department of the laboratory.

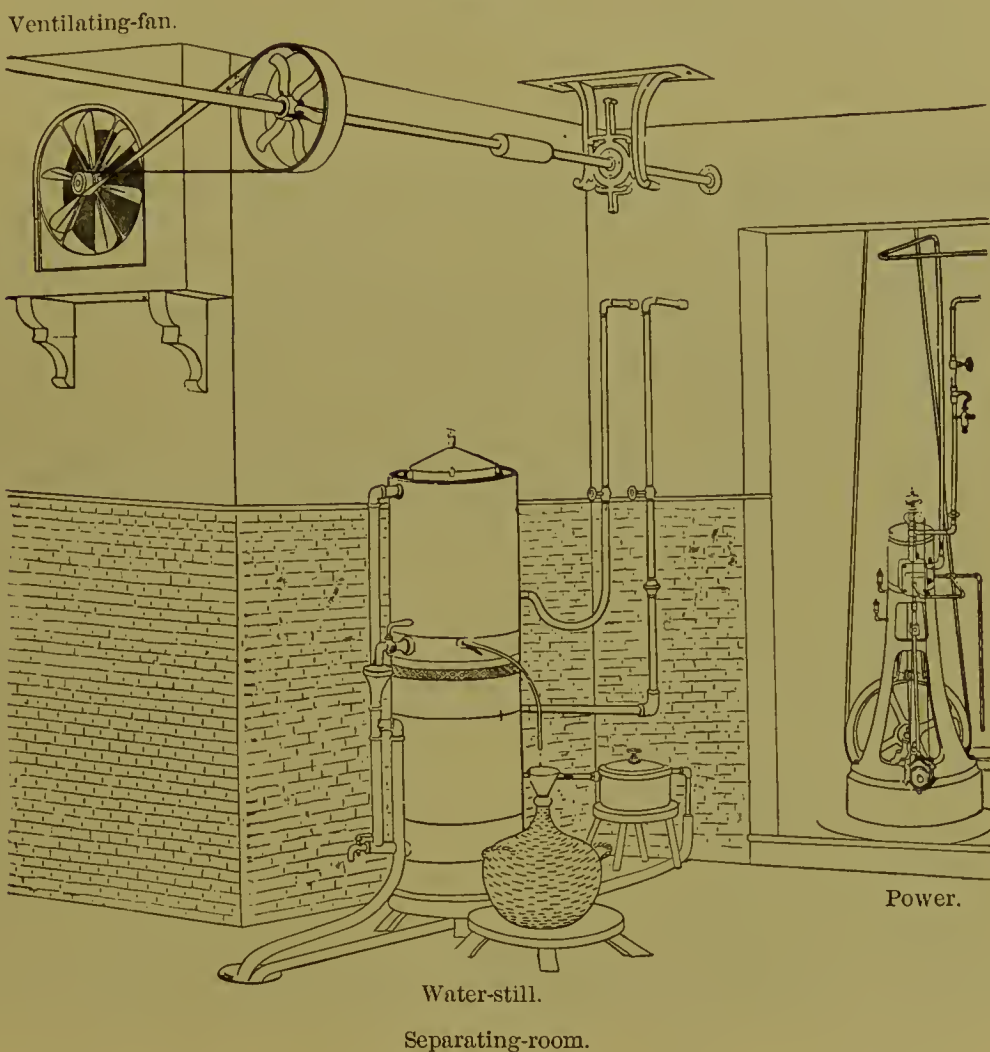
A special room should be provided for the milk-modifiers who are to put up the mixtures required by each prescription.

There should also be a room where the milk is separated by means of machinery and where it can be tested and steamed.

The office at the laboratory should be entirely separate from these work-rooms, so that customers coming to leave their orders should not go near the materials used for modification and thus possibly contaminate them.

It is necessary, also, that all odors should be excluded from the work-rooms, as milk absorbs odors very quickly.

FIG. 51.



It is hardly necessary to say that the employees of a laboratory, whether they be in the office or in the work-rooms, should be intelligent and interested in their work.

I have explained to you in a general way the chief requirements of a milk-laboratory. I will now take you to the Laboratory and explain to you on the spot the various details which must be understood by the physician so that he can intelligently order what is best fitted for the infant under his charge.

**MILK-ROOM.**—We are now in the milk-room (Fig. 50, page 246), where the milk is received on its arrival from the farm.

The milk from the farm is delivered here in the milk-room within a few hours from the time of the milking. You saw how it was aerated at the



farm and cooled to about  $6.66^{\circ}\text{C}$ . ( $44^{\circ}\text{F}$ .), and you now see that on its arrival at the milk-room its temperature is found to have been held by means of ice during the transportation below  $7.22^{\circ}\text{C}$ . ( $45^{\circ}\text{F}$ .). You see how it has been transported in these boxes and how the man in charge of the room has had it placed in the tanks of ice-water.

This milk, as a result of the especial manner in which the cows have been fed and cared for and the selection of them according to the proper breed, may be said to have an almost uniform percentage of its elements. Even at those times of the year when the percentages of the different elements of milk commonly vary from changes in the pasturage and in the habits and surroundings of the animals, the milk of these cows, which have their food supplied to them in stated rations at one time of the year as well as another, is not subject to the elemental variations which occur in the milk of ordinary cows.

Having seen here in the milk-room the methods by which the milk is treated and is kept uncontaminated, we will visit the separating-room, where the milk is taken to prepare it for the modifying clerk.

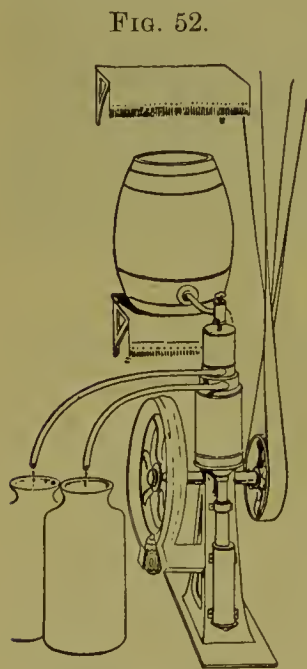
**SEPARATING-ROOM.**—This room (Fig. 51, page 247) is arranged and cared for in very much the same way as is the milk-house at the farm. The walls are of white tile, and the ceilings are of material which can be washed and scrubbed. The floor is of asphalt, impenetrable to water, and is kept thoroughly moistened and free from every kind of dirt and dust.

**Ventilator.**—In addition to the precautions against pathogenic germs, which I have already explained to you, the air of the separating-room is kept fresh and pure by means of this *ventilator* which you see in the corner of the room. It consists of a large steel fan, which revolves at the rate of two thousand times a minute, and by the force of its current carries away any flies or particles of dust which may come within its reach.

**Separator.**—Here is a piece of machinery of great delicacy, called the *Centrifugal Separator* (Fig. 52).

This separator is made to revolve six thousand eight hundred times in a minute, and works with such searching effect on the milk that only a small percentage (0.13) of fat remains in the separated milk.

The utility of the separator, however, does not consist wholly in its absolute withdrawal of the fat from the milk and in providing cream as fresh as to time as is the separated whole milk: it accomplishes two other very important results. First, by its great centrifugal force it separates from the cream and the separated milk any dirt or foreign matter of any kind which necessarily gets into every milk, and thus provides at once a practically clean milk, a most important result from a bacteriological point of view. Secondly, the resulting cream has an almost



Centrifugal separator.



stable percentage of fat,—sixteen per cent.,—the importance, of course, of this being in its stability, and not in its special percentage.

**Still.**—We also have in this room (separating-room, p. 247) a still for freshly preparing each day distilled water.

In this next room you will see the steam-power (represented to right of separating-room, p. 247) which runs the ventilating-fan, the separator, the water-still, and the sterilizer which I shall presently describe to you.

**MODIFYING-ROOM.**—We are now in the modifying-room, where the milk is tested, where the materials for preparing the food are brought from the different rooms when needed, and where the modification of the milk is completed.

FIG. 53.



Modifying-room.

**Babcock Milk-Tester.**—To be doubly sure that the chemistry of the milk is what we suppose it to be from the uniform nature of the primal milk-supply, we take advantage of the knowledge which we have concerning the changes most likely to take place in certain elements of the milk.

The percentage of the proteids, of the sugar, and of the mineral matter in the milk of a herd of this kind, where uniformity in the feeding is the rule, is not apt to be appreciably affected. But the percentage of the fat in individual cows differs from day to day, and thus slightly affects the percentage of the fat in the milk of the herd.

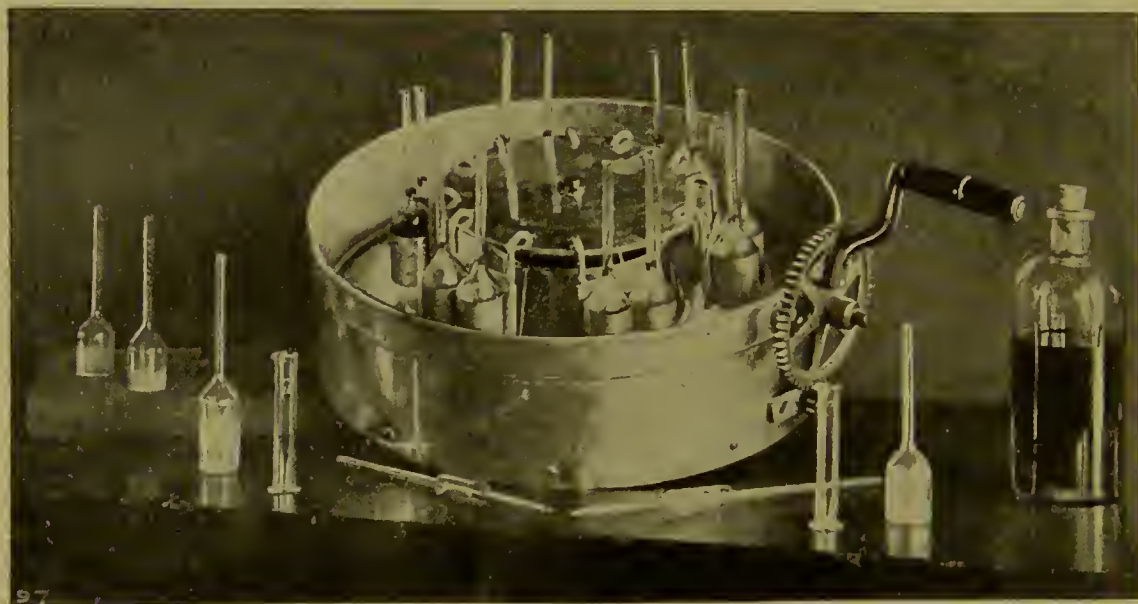
The fat, then, being the element by which we know whether each milking gives a uniform product, we test this element by means of what is called the "Babcock Milk-Tester." I have here on this table the Babcock

machine, and I will have the percentage of the fat in a specimen of this morning's milk tested for you.

The peculiar feature of this method of ascertaining the percentage of fat in milk, as described in the Wisconsin Experiment Station, Bulletin No. 24, July, 1890, consists in placing these test-bottles containing the acidified milk in a centrifugal machine, by the rapid revolution of which the fat is made to separate quickly and completely. The milk is acidified in order that the proteids, casein and fibrin, may be changed to soluble acid albumins, which offer less resistance to the rising and aggregation of the fat-globules.

Approximately equal volumes of milk and commercial sulphuric acid of 1.82 specific gravity are mixed in a test-bottle with a long graduated neck. This pipette, delivering about 17.5 c.c. of milk, and this measuring cylinder

FIG. 54.



Babcock milk-tester.

for the acid, are used. The acid is in this large bottle to the right of the machine. The bottles are whirled for several minutes at a temperature of  $93^{\circ}\text{C}$ . ( $200^{\circ}\text{F}$ .) in a horizontal wheel making from seven to eight hundred revolutions per minute. This wheel is surrounded by a copper jacket, which may be filled with hot water for heating during the test. The separation of fat by gravity alone is not complete even when the bottles are left standing for several hours. By centrifuge, however, a perfect separation is accomplished in a few minutes. If whirled at once, no heat need be applied, as that caused by the strong acid and milk is sufficient. After whirling, the bottles are filled to the neck with hot water, returned to the machine, and whirled for one or two minutes longer, after which they are filled with hot water to about this seven per cent. mark, and the machine is again turned for a short time, the temperature being kept up by means of a lamp or by filling the jacket with hot water. The fat separates and its percentage is noted while still liquid, preferably at about  $65^{\circ}\text{C}$ . ( $150^{\circ}\text{F}$ .), the reading



giving the percentage of fat directly without calculation and being easily taken to 0.1 per cent.

This daily testing of the fat enables the modifier to preserve the accuracy of his material, and to correct any variation in the percentage of the cream as it comes from the separator.

The milk this morning shows four per cent. of fat, and therefore we conclude that we are dealing with the usual uniform milk expected to come from the farm. The average and almost stable analysis of this milk throughout the year shows a percentage of fat of 4.00, and is the basis on which the office clerk makes the calculation by which the percentage of the fat called for in the various prescriptions is exactly obtained. Knowing the exact percentages of this milk, the office clerk can, by a simple mathematical formula, give the required directions on the modifying clerk's formula for obtaining whatever percentages of the other elements the physician may call for.

Here are the figures (Analysis 46) which have been found to result from many analyses of the milk of the herd which you saw at the farm :

ANALYSIS 46.

Fat . . . . .	4.00
Sugar . . . . .	4.30
Proteids . . . . .	4.00
Ash . . . . .	0.65
Total solids . . . . .	12.95
Water . . . . .	87.05
	<hr/> 100.00

I have also had placed here on another table for your inspection the modifying materials used for making up the prescriptions.

FIG. 55.



Modifying materials.

In this large glass jar on the left side of the table is the stable cream obtained from the separator, which is used in obtaining the prescribed percentage of fat. On the right side of the table is another large glass jar



which contains the separated milk, also of stable percentage, obtained from the separator, and which is used for obtaining the different percentages of the proteids as called for in the prescription.

We must, of course, allow that the *cream* as well as the separated *milk* contains its own definite percentages of sugar, proteids, and mineral matter. This analysis (Analysis 47) shows the percentages of the fat, sugar, and proteids in this cream and separated milk :

ANALYSIS 47.

	Fat.	Sugar.	Proteids.
Cream . . . . .	16.00	4.00	3.60
Separated milk . . . . .	0.13	4.40	4.00

To provide the means for adjusting the percentages of the *sugar* which are called for, a carefully prepared twenty per cent. solution of milk-sugar and distilled water is used, and is kept in this large glass jar which stands beside the cream-jar. The reaction of the food is adjusted by means of the *lime water* which you see in this large glass jar beside the separated milk, and which is freshly prepared every day.

The other jars on the table contain specimens of cream of different percentages, and preparations of *oats*, *barley*, and *wheat*, which are freshly prepared at the Laboratory each day, and which can be used for infants when they are old enough to have starch added to their food.

With these modifying materials the modifying clerks combine each infant's food according to the prescription before them, and pour it into the glass tubes from which the infant is to nurse. These tubes, which you see standing in their baskets on the modifying clerks' table, have been especially devised as the most practical for general use, are adapted both for transportation and for use as nursing-bottles, and are easily cleansed.

There are two sets of clerks. (See page 249.) One set is engaged in modifying the milk according to the prescriptions. As soon as the tubes are filled by the modifying clerks they are passed on to the stoppling clerks, who immediately seal them with aseptic non-absorbent cotton especially prepared for this purpose, and place them in these baskets adapted as to their compartments to the number of feedings ordered for the special infant. Here are some baskets which hold eight, some which hold ten, and some which hold four tubes. The tubes are kept on tube-racks within easy reach of the modifying clerks. Each basket has its own label attached to it, with the address of the person to whom it is to be sent.

The rule of absolute cleanliness is carried out in every possible detail, from the table on which the materials are combined to the dress and hands of the clerks.

When the milk has been separated, recombined according to the prescriptions, stoppled, and placed in the respective baskets, the baskets are taken from the modifying-room to the separating-room.

STERILIZER.—We will now return to the separating-room (page 247)

and see the baskets placed in this large sterilizer (Fig. 56), which has a capacity of 240 kilogrammes (500 pints).

The sterilizer is so arranged that the steam which passes through it can be regulated so as to produce any degree of heat required up to  $100^{\circ}\text{C}$ . ( $212^{\circ}\text{F}$ ). This is accomplished by a regulator attached to the steam-pipe, and, as you see, the man in charge of the heating of the food, by keeping his hand on the regulator and his eye on the thermometer which is fitted to the sterilizer, can subject the baskets and the tubes in them to whatever degree of heat is ordered, and of course for the length of time required.

After the food has been heated, the baskets are taken out of the sterilizer and placed in the cooling-tank, where the temperature of the food is reduced to  $13.3^{\circ}\text{C}$ . ( $38^{\circ}\text{F}$ ).

FIG. 56.

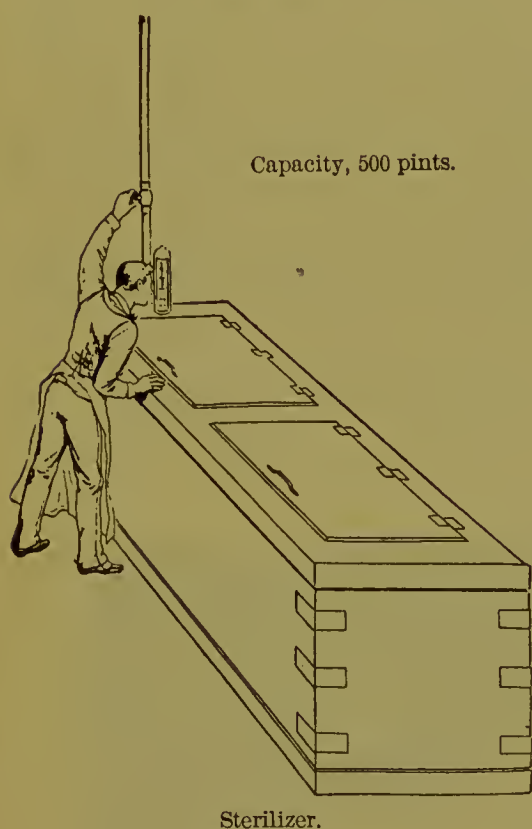
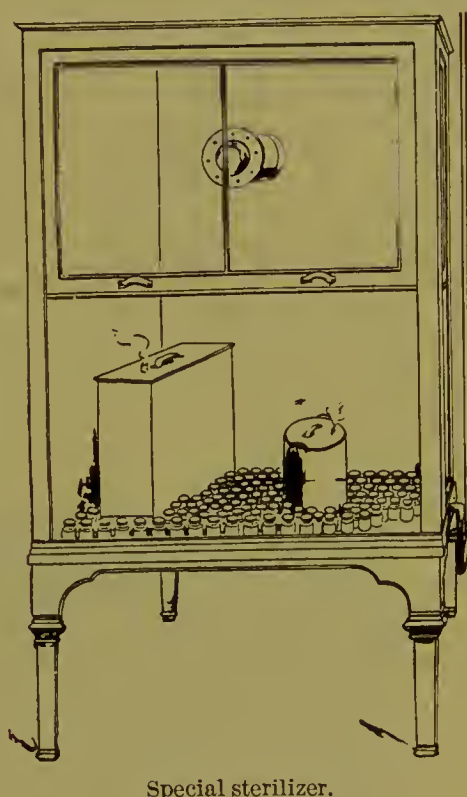


FIG. 57.



The baskets are then placed in the delivery-wagon, which quickly conveys them to their various destinations.

Where a special prescription at an unusual time of the day is called for, it is heated in this hood and special sterilizer (Fig. 57).

When the baskets are delivered at the homes of the consumers, the baskets and tubes of the previous day are returned to the Laboratory. When they reach the Laboratory they are taken directly from the street to the wash-room (Fig. 58), which is entirely shut off, as I have before told you, from the rest of the Laboratory.

WASH-ROOM.—Here in the wash-room (Fig. 58), in order to carry out absolutely the aseptic precautions, the baskets and everything which has been returned to the Laboratory are placed in this special sterilizer belonging

to the wash-room. You observe that the baskets and tubes are just being taken out of the sterilizer. The bottles, after being sterilized, are thoroughly washed in these tubs, which are especially adapted for this purpose, in a solution of soda and water. All the tags and stoppers are destroyed after sterilization. The baskets are of woven willow, and are easily kept sterile.

FIG. 58.

Aseptic precautions.



Wash-room and sterilizer for returned materials.

In this way, always guarding against possible infection of all kinds, the Laboratory enables us to make use of the chemical and bacteriological knowledge which we have acquired in connection with the feeding of infants, and fulfils the requirements of that system of substitute feeding which up to the present time has proved to be the best.

You will now have an opportunity of seeing the returned baskets and tubes actually steamed in the sterilizer (Fig. 59).

The doors of the sterilizer are tightly clamped, and Mr. Gordon has just ordered the steam to be turned into it.

MODIFICATION.—We will suppose that you wish to prescribe some modified milk for an infant four months old, with normal digestion and of

FIG. 59.



Sterilizer, containing returned baskets and tubes.

normal weight and general development. The regular prescription-blank issued by the Laboratory can be used if you have one, but, of course, a milk-prescription can be written as you would write a prescription for a



drug. Here is one of the prescription-blanks that I am in the habit of using at this special Laboratory, and which I will fill with some supposed directions.

PRESCRIPTION BLANK.		
<div>R</div>		
	Per Cent.	
Fat . . . . .	4 00	Reaction . . . . . Slightly alkaline.
Milk-Sugar . . . . .	7 00	Number of Feedings . . . . . 7
Proteids . . . . .	1 50	Amount at each Feeding . . . 135 c.c. ( $\frac{3}{4}$ 4½)
Mineral Matter . . . . .		Heated for . . . . . 20 minutes.
Lime Water . . . . .		75° C.
		Heated at . . . . . 167° F.
Special Directions.		Remarks.
For Whom Ordered.		Infant's Age? . . . . . 4 months.
		Infant's Weight? . . . . . 14 pounds.
Date.		Signature.
		M.D.

I shall direct the percentage of fat to be 4, that of sugar 7, that of the proteids 1.5. I shall order the reaction to be slightly alkaline.

In regard to the question of the reaction, it can be left to the milk-modifier, as we leave to him the carrying out of other directions contained in the prescription. If the milk brought to the Laboratory on the special day when we are sending our prescription has been produced from cows fed, as I have previously described, on sugar-beets, the milk may be already sufficiently alkaline for an infant's digestion when normal. If, on the contrary, the milk has its usual acid or amphoteric reaction, the milk-modifier will make it slightly alkaline, in accordance with our prescription and according as the milk of the special day has a greater or less acid reaction. For this purpose lime water should be used, as being the best material and as least likely to do harm. If, however, the infant's digestion is not normal and we wish to prescribe a precise amount of lime water, we can do so by writing for whatever percentage we choose, as we do for the other elements of the milk. In modifying the milk which comes from the farm connected with this Laboratory, as a rule, one-twentieth part of lime water (five per cent.) is sufficient to make the reaction correspond to that of normal human milk. By referring to this table (Table 60) you will see what the percentage of lime water should be in order to obtain a greater or less degree of alkalinity. The hydrate of lime is said to be soluble to the extent of 1 part in 778 parts of water at a temperature of 15.5° C. (60° F.). This would make one ounce of lime water to contain rather more than 0.03 (½ grain) of CaO<sub>2</sub>H<sub>2</sub> (hydrate of lime).

I shall write for seven feedings, and make the amount at each feeding 135 c.c. ( $4\frac{1}{2}$  ounces).

I showed you at a previous lecture (Lecture VIII., p. 221) that the milk from the farm connected with the Laboratory has proved to be comparatively free from bacteria, and that it would probably be unnecessary to destroy the few bacteria which exist in it if the infant could be immediately fed here in the Laboratory. As this is not possible, and as the milk has to be transported from the Laboratory to the homes of the consumers at various distances, I have found it better to heat the milk to  $75^{\circ}$  C. ( $167^{\circ}$  F.). This temperature, as I have already explained to you, is sufficient to kill those developed bacteria which would be of any harm to the digestion of the infant, and at the same time is below  $77.2^{\circ}$  C. ( $171^{\circ}$  F.), the point at which coagulation of the proteids is supposed to take place. We thus obtain a practically pure fresh milk, uncooked and sterile. We therefore write in our prescription  $75^{\circ}$  C. ( $167^{\circ}$  F.). If, however, the milk is to be sent a long distance, if the weather is hot, or if the milk-supply has to last more than twenty-four hours, a higher degree of heating can be used, according to the wish of the prescriber. Thus,  $100^{\circ}$  C. ( $212^{\circ}$  F.) is a temperature used for these purposes at the Laboratory. Where, again, we wish the milk to be absolutely sterilized, as may be the case when we are preparing it for an ocean voyage or for a trip across the continent, not only a high degree of heat,  $100^{\circ}$  C. ( $212^{\circ}$  F.), but two or three heatings, with intervals of some hours, are necessary for this complete sterilization, and this can be called for in our prescription. The length of time during which the milk should be heated, as a rule, can be left to the judgment of the superintendent. I have already shown you in this table (Table 55) that ten minutes is often sufficient to kill the developed bacteria and to make this especial milk practically sterile. Experience, however, has proved that during transportation the milk is often exposed to temperatures conducive to the further development of bacteria, and that practically the bacteriological results which we obtain in the Laboratory do not entirely hold when the milk is exposed to these varied conditions of transit. As a rule, therefore, from twenty to thirty minutes is the proper time to heat mixtures of modified milk sent from the Laboratory.

I shall also, for record in the Laboratory and for reference later, state on the prescription the infant's age and weight.

Finally I shall date the prescription, write on it the address where the food is to be delivered, and sign it.

This prescription is now handed to the clerk in the office. The clerk copies it into this book, which records each day's feeding of each individual infant, and then translates the physician's prescription into such form as can be readily understood by the modifying clerks. Of course this form may vary in different parts of the world, according as the metric or the apothecary system is in use. In the work of this especial Laboratory, although the prescriptions are written by the physicians in the metric system, it has

been found more convenient, when delivered to the patrons of the Laboratory, to have the amounts expressed in ounces and drachms. The office clerk, after translating the metric percentages into ounces and drachms, copies it on to a blank of this form, which is called the modifying clerk's prescription :

MODIFYING CLERK'S PRESCRIPTION.			
No. ....			Put up by
Name of Infant			Date .....
Age of Infant . . . . . 4 mos. wks. days.			Month .....
Weight of Infant . . . . . 14 lbs. oz.			
Address .....			
Send by..... at.....o'clock.			1 17
			2 18
			3 19
			4 20
			5 21
			6 22
			7 23
			8 24
			9 25
			10 26
			11 27
			12 28
			13 29
			14 30
			15 31
			16
<i>Physician's Prescription.</i>		<i>Clerk's Formula.</i>	
	Per Cent.	Oz. Dr.	
Fat . . . . .	4 00	Modifying Cream . . . . .	7 7
Milk-Sugar . . . . .	7 00	Modifying Milk . . . . .	4 7
Proteids . . . . .	1 50	Sugar Solution . . . . .	8 3
Mineral Matter . . . . .		Lime Water . . . . .	1 5
Lime Water . . . . .		Water . . . . .	8 6
		Total . . . . .	31 : 4
No. of Feedings . . . . . 7			
Amount at each Feeding . . . . . 4½ ounces.			
Heated at . . . . . 167° F.			
Time in Sterilizer . . . . . 20 minutes.			
Remarks.			
Copied.....189.....by.....			

This prescription is then plaeced in the hands of the modifying clerk, who combines the different elements of the prescription by means of the elemental materials which have been brought into the modifying-room from a different part of the Laboratory, and which I have already described.

I have requested physieians to write their prescriptions within certain limits as to the percentages of the fat, sugar, and proteids, and to allow the mineral matter for the present to regulate itself. The limits which up to the present time the Laboratory has found it necessary to plaee on the pre-scriptions for the milk-modifiers, and within which the modifying clerk is supposed to put up the prescriptions, are as is shown in this table (Table 63) :



TABLE 63.

Fat . . . . .	from 0.03 to 36.00
Sugar . . . . .	from 0.87 to 20.00
Proteids . . . . .	from 0.22 to 4.00

There is not much doubt that in the future more and more exact results will be obtained, representing definite percentages of still wider limits. The results obtained from combining the modifying materials used by the modifying clerks have so often been proved to be practically correct, that we can assume that when we write a prescription we shall obtain in return a product which in its various elements comes within a fraction of one per cent.

I have arranged in this table (Table 64) figures which will aid you in writing for such percentages of the fat, sugar, and proteids as can be obtained at the Laboratory :

TABLE 64.

*Practical Limits of Milk-Modification which can be accomplished in the Laboratory.*

I.				
Low Fats.				
Fat . . . . .	0.03	0.04	0.08	0.12-16
Sugar . . . . .	2.00	3.00	4-5.00	6.00-7.00
Proteids . . . . .	0.75	1.00	2.00	3.00-4.00
II.				
Low Sugars.				
Sugar . . . . .	0.87	1.40	2.12	3.50-4.30
Fat . . . . .	2.00	3.00	3.50	4.00
Proteids . . . . .	0.75	1.00	2.00	3.00-4.00
III.				
Low Proteids.				
Proteids . . . . .	0.22	0.34	0.45	0.53
Fat . . . . .	2.00	3.00	4.00	4.50
Sugar . . . . .	2.00	3.00	4.00-5.00	6.00-7.00

FIG. 60.



You see that in I. I have taken the lowest percentage of fat which can practically be used at the Laboratory and have combined it with various percentages of sugar and of proteids. In II., in like manner, I have taken the lowest percentages of the sugar which can be combined with these various percentages of fat and proteids. Finally, in III. I have made the same calculations for the proteids.

Other materials can also be obtained at the Laboratory on the physician's prescription for older infants and children, notably preparations of oats, barley, and wheat, which you see this young woman (Fig. 60) preparing in a special apparatus devised for steaming these cereals.

When a physician orders cereals to be prepared at the Laboratory, he is

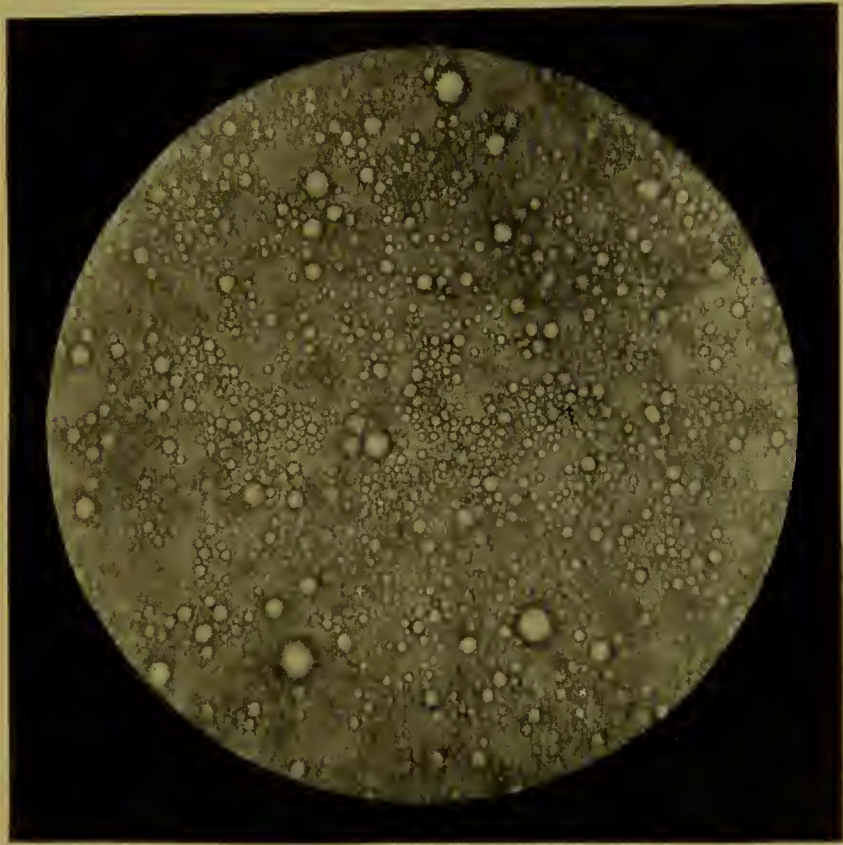
enabled by this apparatus to obtain exact preparations as to the percentages of the constituents of any cereal foods. This is accomplished by employing an analysis of the special cereal ordered, and, with distilled water as a diluent, regulating the time the heating shall be maintained with "live steam" around the porcelain crocks.

The question having arisen whether the emulsion of milk which is used for modification is interfered with or destroyed by modification, I have answered it in the following way :

Under each of these four microscopes there is a drop of milk strongly magnified.

Under the first microscope (Fig. 61) you will see a drop of milk as it

FIG. 61.



Cow's milk.

came from the cow, unmodified and unchanged, except as it might have been affected by transportation from the farm.

The analysis (Analysis 48) of the milk from which this drop was taken is as follows :

ANALYSIS 48.

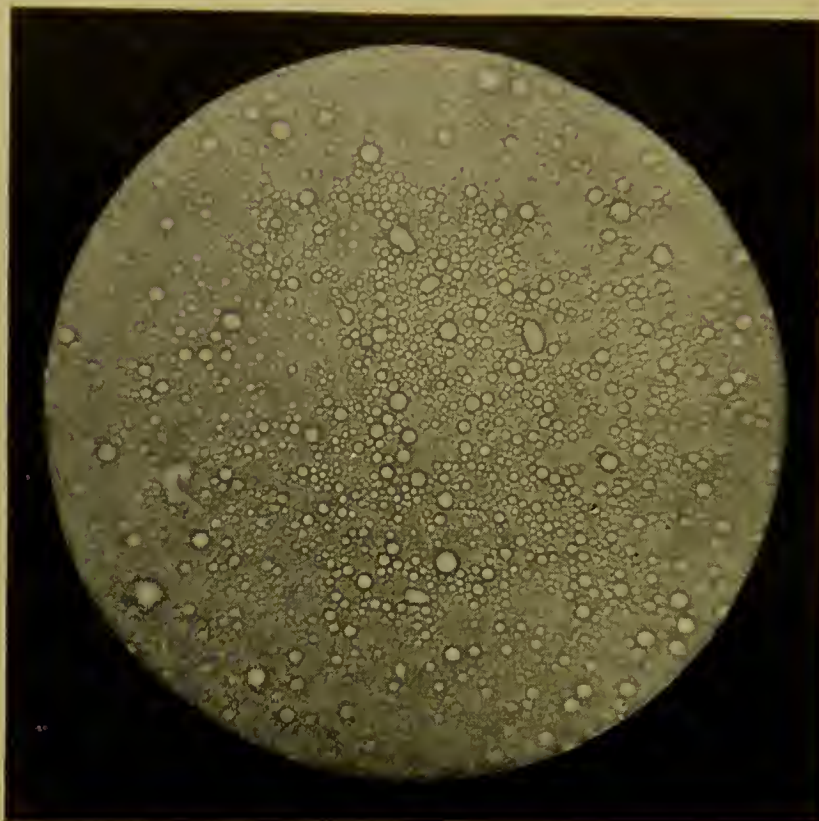
*Cow's Milk.*

Fat . . . . .	4.04
Sugar . . . . .	4.55
Proteids . . . . .	4.15
Ash . . . . .	0.71
Total solids . . . . .	13.45
Water . . . . .	86.55
	<hr/> 100.00



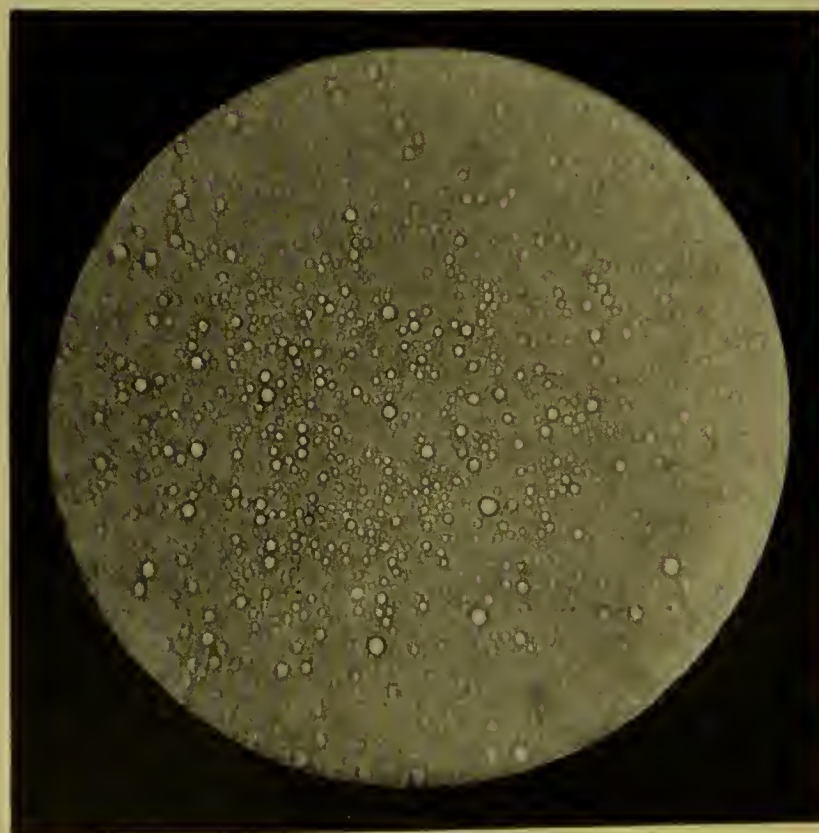
Under this second microscope (Fig. 62) is a drop of a mixture which has been so treated as to represent the same analysis (Analysis 48) as that

FIG. 62.



Cow's milk separated and recomposed.

FIG. 63.



Human milk.



of the original whole milk, and which in fact is the original whole milk as seen in Fig. 61, which has been separated and recomposed.

You will notice that the emulsion of the recomposed milk is quite as good as that of the original whole milk from which it was separated.

Under this third microscope (Fig. 63) I have placed a specimen of human milk.

The analysis (Analysis 49) of this milk was sent to me in order that I should have a food modified to correspond to it, to be used for the purpose of a mixed feeding :

ANALYSIS 49.

<i>Human Milk.</i>	
Fat . . . . .	2.67
Sugar . . . . .	6.37
Proteids . . . . .	2.69
Ash . . . . .	0.15
Total solids . . . . .	11.88
Water . . . . .	88.12
	100.00

Under this fourth microscope (Fig. 64) is a specimen of cow's milk modified to correspond to the human milk which is under the third microscope (Fig. 63).

FIG. 64.

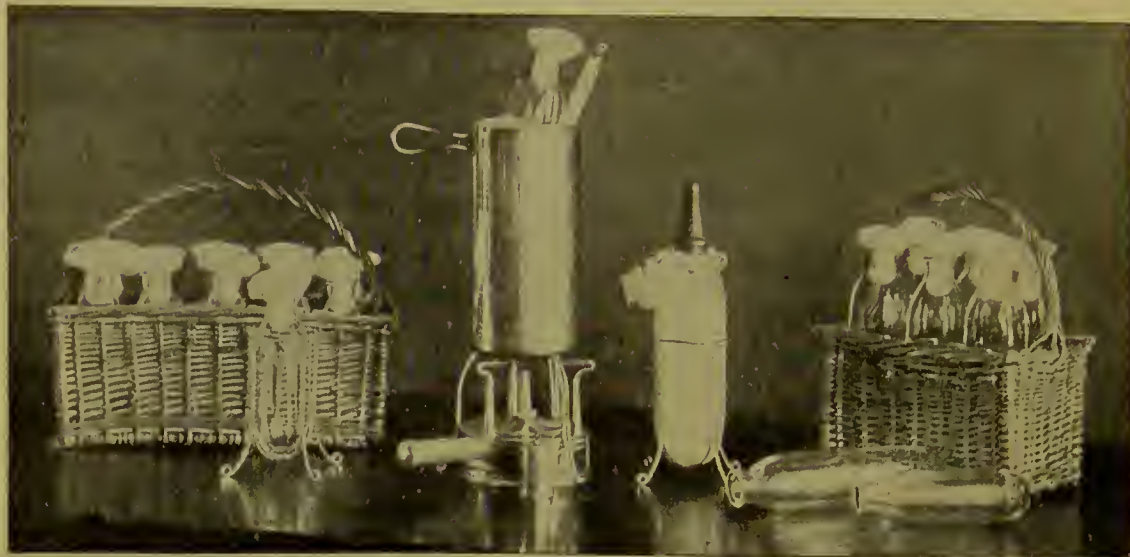


Modified milk.

You see that the emulsion corresponds almost exactly : so that there is no question that it is not injurious, so far as the emulsion is concerned, to separate the elements of milk and then recombine them.

I shall now take you back to the office and show you the various forms of apparatus which are provided for feeding the infant in its home. I have had some of them placed on this table (Fig. 65).

FIG. 65.



In the left of the picture is a basket holding eight tubes of a capacity of six ounces each. In front of this basket is a four-ounce tube in a wire stand. In the middle of the picture is a tin apparatus for warming the milk at the time of feeding. An alcohol lamp is shown beneath the warmer, and a tube of milk and a thermometer for testing the temperature of the milk are in the tin-warmer. Next to and to the right of the tin-warmer is a tube with a capacity of eight ounces. It is enclosed in a white worsted cozy, has the rubber nipple in place, and is supported in a wire stand. In the right of the picture is a basket containing six tubes with a capacity of eight ounces each. In front of this basket are an eight-ounce tube and a four-ounce tube.

This apparatus is very simple and practical for transportation. A wicker basket, divided into a number of compartments corresponding to the number of feedings which are to be sent to the infant, has been found to be the most practical. These baskets with their tubes can be placed, as you saw, directly in the sterilizer, and are not harmed by the heat to which it is necessary to expose the food.

This tin receptacle can be placed above an alcohol lamp; the water in it is to be on a level with the height of the milk which is contained in the tube, and the tube is submerged in the water. It has been found necessary to take the temperature of the food by means of a thermometer placed directly in the tube. No rule can be laid down by which the temperature of the water-bath determines that of the milk, unless the tubes are of uniform thickness and the milk uniform in quantity and temperature when placed in the bath. The thermometer must be washed in sterilized water with the greatest care, both before and after it is used. The food when given to the infant should have a temperature of from  $36.6^{\circ}$  to  $37.7^{\circ}$  C. ( $98^{\circ}$ – $100^{\circ}$  F.).

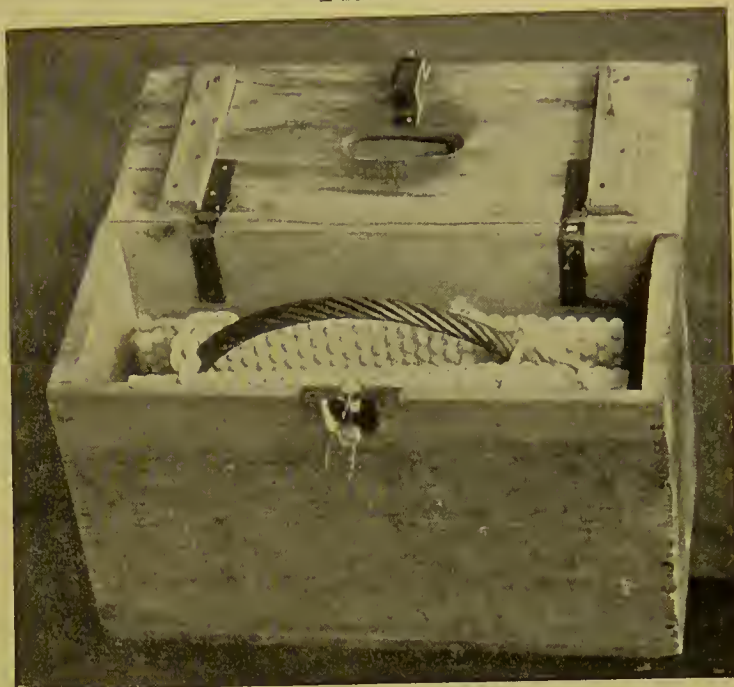
As in direct feeding from the breast the food which the infant receives has the same temperature at the end of the feeding as at the beginning, we should copy this provision of nature and not allow the temperature of the food to vary during the time it is being taken. To accomplish this end, this white worsted cozy can be used. The cozy is warmed at the same time that the milk is being heated, and the tube when placed in it is prevented from cooling.



Thus the infant receives a food of unvarying temperature throughout the whole of the feeding.

FIG. 66.

I have here also to show to you the various means which are used in transporting the food when it has to be sent long distances. Here is a transportation-box (Fig. 66), which is used in cold weather, when ice is not necessary to preserve the freshness of the milk.



Transportation-box, containing basket and tubes.

This box (Fig. 67) is one which can be used in hot weather, and has proved to be of great practical utility. It admirably serves the purposes of an express box and of a home refrigerator. The ice, as you see, is packed in a metal receptacle in the middle of the box, and the tubes are placed, each in its own compartment, around the sides of the ice-receptacle.

FIG. 67.



Ice-box, holding twelve tubes. Receptacle for ice in centre of box. Laboratory prescription-blank in front of box, and packing-paper under end of open lid.

I shall now call your attention to two cases which were fed under my direction at the Milk-Laboratory during the first year of their lives, and which merely illustrate the changes which naturally would be made during this period in the food of a healthy infant.



The first case (Case 91) was a male, born November 18, 1892. This table (Table 65) shows the record of its weight and food during its first year :

TABLE 65.

*Showing Management of the Food and Increase in Weight of a Healthy Infant (Case 91) during the First Fifty-Two Weeks of its Life.*

DATE.	Weeks of Life.	WEIGHT.			Amount at each Feeding.		PERCENTAGES OF FOOD.			
							Fat.	Sugar.	Proteids.	Lime Water.
November 18 . .	1	Grams. 3752	Lbs. 8	Oz. 6	C.c. 30	Oz. 1	2.00	6.00	1.00	5.00
	2									
	3	. . .	. . .	. . .	. . .	. . .	3.00	6.00	1.00	
	4	. . .	. . .	. . .	45	1½				
December 23 . .	5	. . .	. . .	. . .	75	2½	4.00	7.00	1.00	10.00
	6	4284	9	9	90	3				
	7									
January 13 . . .	8						. . .	. . . .	. . . .	5.00
	9	6944	15	8	105	3½				
	10									
	11									
February 17 . .	12									
	13	. . .	. . .	. . .	120	4				
	14	6048	13	7	135	4½	4.00	7.00	2.00	
	15									
March 17 . . . .	16									
	17									
	18	6748	15	1	150	5				
	19									
April 21 . . . .	20									
	21									
	22									
	23	7308	16	5	165	5½				
May 18 . . . . .	24									
	25									
	26									
	27	7504	16	12	180	6	4.00	7.00	2.50	
June 22 . . . . .	28									
	29									
	30									
	31									
August 17 . . . .	32	7840	17	8						
	33	. . .	. . .	. . .	210	7				
	34	. . .	. . .	. . .	. . .	. . .	4.00	7.00	3.00	12.50
	35	. . .	. . .	. . .	. . .	. . .				
November 9 . . .	36									
	37	. . .	. . .	. . .	. . .	. . .	4.00	7.00	2.50	
	38	. . .	. . .	. . .	. . .	. . .	3.50	6.50	1.50	10 00
	39	. . .	. . .	. . .	180	6	4.00	7.00	2.00	5 00
November 9 . . .	40	8820	19	11	225	7½				
	41	. . .	. . .	. . .	. . .	. . .				10.00
	42	. . .	. . .	. . .	. . .	. . .				12.50
	43	. . .	. . .	. . .	. . .	. . .	4.00	6.00	2.50	10.00
November 9 . . .	44	. . .	. . .	. . .	. . .	. . .	4.00	5.00	3.00	5.00
	45									
	46									
	47	. . .	. . .	. . .	. . .	. . .	Whole milk.			
November 9 . . .	48									
	49	. . .	. . .	. . .	. . .	. . .	Whole milk and oat jelly.			
	50									
	51									
November 9 . . .	52	9870	22							

Food heated throughout the year at 75° C. (167° F.).

The grammes in the third column have been reduced to pounds and ounces on the basis of 28 grammes to the ounce, and the fractions of the ounce have been disregarded.

The next case (Case 92) was a female, born November 1, 1892. This chart (Chart 4) shows the line of growth in its weight from birth to the fifty-second week of its life :

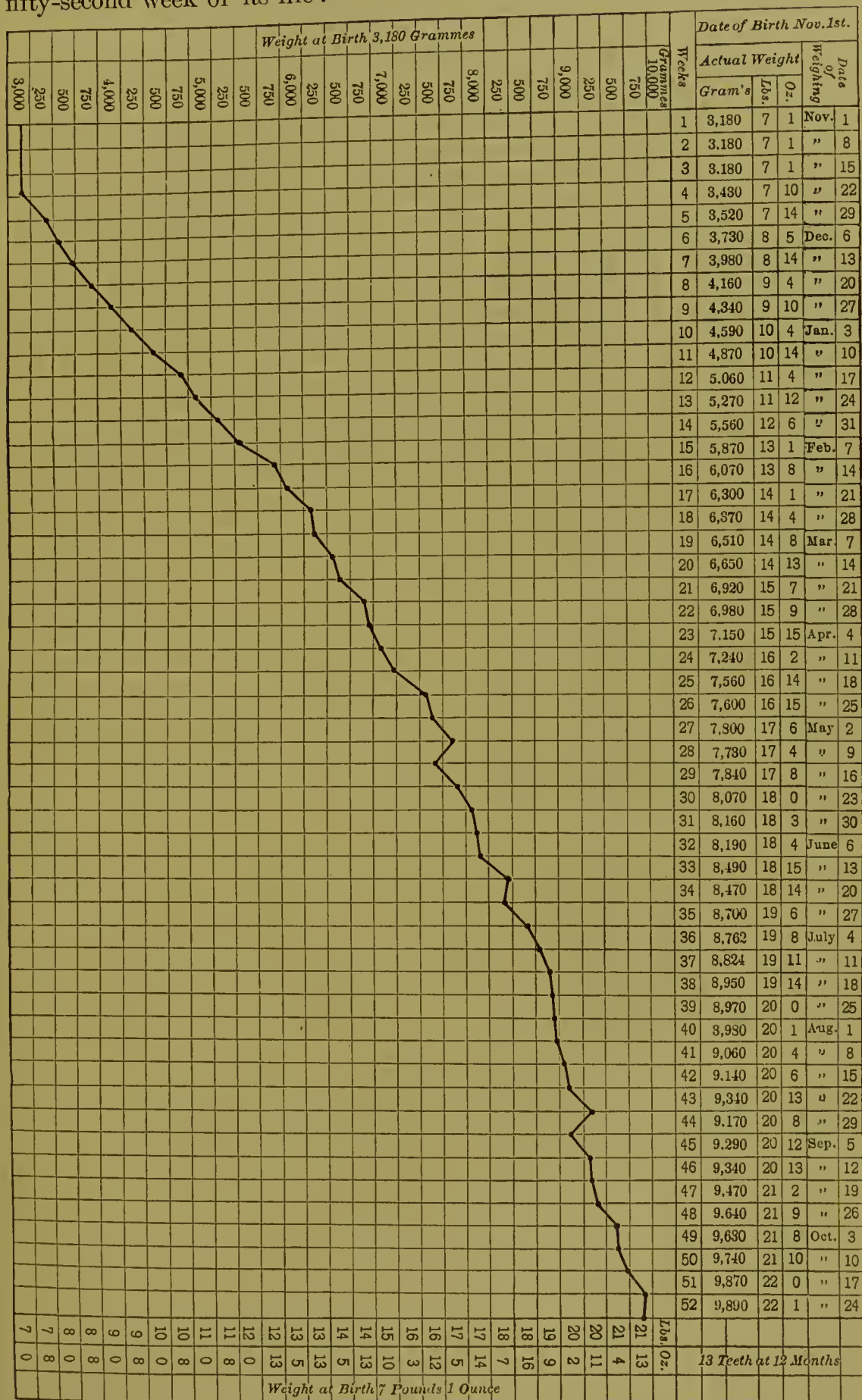


CHART 4.

I have also arranged a table (Table 66) recording the quantity and quality of this infant's (Case 92) food during the first year :

TABLE 66.

*Showing Management of the Food and Increase in Weight of a Healthy Infant (Case 92) during the First Fifty-Two Weeks of its Life.*

DATE.	Weeks of Life.	WEIGHT.			Amount at each Feeding.		PERCENTAGES OF FOOD.			
							Fat.	Sugar.	Proteids.	Lime Water.
		Grams.	Lbs.	Oz.	C.c.	Oz.				
November 1 . . .	1	3180	7	1						
November 8 . . .	2	3180	7	1	60	2	2.00	5.00	1.00	5.00
November 15 . . .	3	3180	7	1	60	2	4.00	7.00	1.00	
November 22 . . .	4	3430	7	10	90	3	4.00	7.00	1.00	
November 29 . . .	5	3520	7	14	75	2½	3.00	7.00	1.00	
December 6 . . .	6	3730	8	5			3.00	6.00	1.00	
December 13 . . .	7	3980	8	14			3.00	7.00	1.00	
Dccember 20 . . .	8	4160	9	4	90	3	4.00	7.00	1.00	10.00
December 27 . . .	9	4340	9	10	105	3½	4.00	7.00	1.25	5.00
January 3 . . .	10	4590	10	4			4.00	7.00	1.50	
January 10 . . .	11	4870	10	14						
January 17 . . .	12	5060	11	4						
January 24 . . .	13	5270	11	12						
January 31 . . .	14	5560	12	6						
February 7 . . .	15	5870	13	1	120	4				12.50
February 14 . . .	16	6070	13	8	135	4½				10.00
February 21 . . .	17	6300	14	1						5.00
February 28 . . .	18	6370	14	4						
March 7 . . .	19	6510	14	8						
March 14 . . .	20	6650	14	13	150	5	4.00	7.00	2.00	
March 21 . . .	21	6920	15	7						
March 28 . . .	22	6980	15	9						
April 4 . . .	23	7150	15	15						
April 11 . . .	24	7240	16	2						
April 18 . . .	25	7560	16	14						
April 25 . . .	26	7600	16	15						
May 2 . . .	27	7800	17	6						
May 9 . . .	28	7730	17	4						
May 16 . . .	29	7840	17	8						
May 23 . . .	30	8070	18	0	180	6				
May 30 . . .	31	8160	18	3						
June 6 . . .	32	8190	18	4						
June 13 . . .	33	8490	18	15	195	6½	4.00	7.00	2.50	
June 20 . . .	34	8470	18	14						
June 27 . . .	35	8700	19	6						
July 4 . . .	36	8762	19	8						
July 11 . . .	37	8824	19	11						
July 18 . . .	38	8950	19	14						
July 25 . . .	39	8970	20	0						
August 1 . . .	40	8980	20	0						
August 8 . . .	41	9060	20	3						
August 15 . . .	42	9140	20	6						
August 22 . . .	43	9340	20	13						
August 29 . . .	44	9170	20	7						
September 5 . . .	45	9290	20	11						
September 12 . . .	46	9340	20	13						
September 19 . . .	47	9470	21	2						
September 26 . . .	48	9640	21	9						
October 3 . . .	49	9630	21	7						
October 10 . . .	50	9740	21	10			4.00	6.00	3.00	
October 17 . . .	51	9870	22	0			Whole milk.			
October 24 . . .	52	9890	22	1			Whole milk and oat jelly			

Food heated throughout the year at 75° C. (167° F.).

The grammes in the third column have been reduced to pounds and ounces on the basis of 28 grammes to the ounce, and the fractions of the ounce have been disregarded.



I shall also mention a few cases which have a practical bearing on the method of substitute feeding by means of milk-laboratories.

The first case illustrates how important it is to be able to vary the percentages of the different elements of the milk, and to know that we are obtaining these variations exactly as they are ordered.

An infant (Case 93) was being nursed by its mother, who was healthy and who had an abundance of breast-milk. Their summer home was by the sea-side, in a healthy situation, and the infant was surrounded with everything that could be desired for perfect hygiene. The infant during the first two months of its life nursed well, thrived, and was perfectly quiescent in its daily life. When it was three months old, the mother was very much worried by some trivial family matters and did not take much exercise. The infant now began to have colic, and, although it gained in weight, it was very restless and cried continuously. An analysis (Analysis 50) of the mother's milk at this time gave the following result:

## ANALYSIS 50.

Fat . . . . .	2.69
Sugar . . . . .	6.15
Proteids . . . . .	3.71
Ash . . . . .	0.17
Total solids . . . . .	12.72
Water . . . . .	87.28
	<hr/> 100.00

The indications for treatment were, of course, to lessen the amount of mental disturbance in the mother and to make her exercise more. The mother having followed these directions, the symptoms in the infant soon became less severe. After a few days, however, the unfavorable symptoms returned, and it was found that the mother had not been exercising and was again mentally disturbed. As it seemed impossible to regulate the function of the mammary gland under these circumstances, it was decided to feed the infant from the Milk-Laboratory. The following prescription (Prescription 5) was ordered:

## PRESCRIPTION 5.

R Fat . . . . .	3.50
Sugar . . . . .	6.50
Proteids . . . . .	1.00
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).
Eight tubes, each holding . . . . .	90 c.c. (3 ounces).

The infant digested this food perfectly, had no colic, and again became tranquil. As, however, it only made a slight gain in weight during the first two or three weeks of this substitute feeding, I changed the prescription to the following one (Prescription 6):

## PRESCRIPTION 6.

R Fat . . . . .	4.00
Sugar . . . . .	7.00
Proteids . . . . .	1.50

On taking this food the infant began to make regular gains in weight, and continued to thrive until it was four months old, when it was brought back to its city home, where it was subjected to many of the annoyances which you will so frequently see occurring in the

families which you take care of, and which, though somewhat disastrous to the infant, tend to advance our knowledge of substitute feeding. The annoyances which I refer to were, in this especial case, as follows. The infant was surrounded with too much excitement, and was exposed to unnecessary changes of temperature in its home. During the process of removal from the sea-side to the city it caught a slight cold, and had intestinal symptoms characterized by loose discharges from the bowels and undigested food. This condition was easily obviated in a few days by simply changing the prescription at the Laboratory to the following one (Prescription 7):

PRESCRIPTION 7.

R Fat . . . . .	2.50
Sugar . . . . .	5.50
Proteids . . . . .	1.00
Lime water . . . . .	10.00

Under this treatment the food was again fairly well digested, the discharges lessened in frequency and they were of a better character. The infant, however, during this sickness had lost over 224 grammes (about ½ pound) in weight.

At this juncture the grandmother of the infant so influenced the mother that she insisted upon having a wet-nurse procured at once. Although I did not approve of this change, the family were so urgent in their demands for a wet-nurse that I procured one for them. This wet-nurse was nursing her own infant and another infant at the Infants' Hospital. Both infants were thriving in every way. An analysis (Analysis 51) of this wet-nurse's milk gave the following results:

ANALYSIS 51.

Fat . . . . .	2.92
Sugar . . . . .	6.20
Proteids . . . . .	4.62
Ash . . . . .	0.16
Total solids . . . . .	13.90
Water . . . . .	86.10
	100.00

The milk for this analysis was taken from the middle of the nursing. The percentage of proteids was so high that I did not dare to allow the foster-infant to be put to the breast at once. I therefore endeavored to regulate the percentages of the elements of the wet-nurse's milk in the usual way. At the end of two days another analysis (Analysis 52) of her milk was made, with the following result:

ANALYSIS 52.

Fat . . . . .	3.39
Sugar . . . . .	5.95
Proteids . . . . .	4.78
Ash . . . . .	0.21
Total solids . . . . .	14.33
Water . . . . .	85.67
	100.00

The extraordinarily high percentage of proteids in this analysis made me absolutely refuse to allow the foster-infant to begin with its nursing from the wet-nurse. The family, however, were very impatient, and argued that, as the other two infants were gaining in weight, digesting well, and looking remarkably ruddy, it must be a good milk which they were receiving from the wet-nurse.

Two days later, although the foster-infant was decidedly improving on the substitute food from the Laboratory, it happened to lose 30 grammes (about 1 ounce) in weight, and the family then insisted that this wet-nurse should be tried. Another analysis of the wet-nurse's milk was then made, and showed that the percentage of the proteids had been reduced to between 3 and 4.

I had already endeavored to find other wet-nurses whose milk would better correspond to what the infant needed, but was unsuccessful in obtaining any the analysis of whose milk showed the percentage of the proteids to be below 3.

I have here the analyses (Analyses 53 and 54) of the milk of two of these wet-nurses, which you may perhaps like to see :

## ANALYSIS 53.

Fat . . . . .	3.88
Sugar . . . . .	6.55
Proteids . . . . .	3.14
Ash . . . . .	0.14
Total solids . . . . .	13.71
Water . . . . .	86.29
	<u>100.00</u>

## ANALYSIS 54.

Fat . . . . .	3.39
Sugar . . . . .	4.50
Proteids . . . . .	4.70
Ash . . . . .	0.18
Total solids . . . . .	12.77
Water . . . . .	87.23
	<u>100.00</u>

The first wet-nurse was then brought to the foster-infant's home, and the infant was put to the breast. It absolutely refused to take the breast for twelve hours, although it was crying with hunger. Finally it was induced to nurse, but immediately after the nursing had an attack of colic. These attacks of colic were more or less severe and occurred after each nursing. The infant soon appeared to like the milk and took it eagerly at the regular nursing intervals. In twenty-four hours from the time when the infant began to nurse its bowels were again affected. The number of discharges became frequent, and the milk evidently was not being digested well. These conditions lasted for several days, when it was found that the infant had lost over 480 grammes (about 1 pound) in weight. As the severity of the colic was increasing, and as the infant had lost its color, the mother agreed to have the feeding by the wet-nurse discontinued. I then wrote the following prescription (Prescription 8) to be put up at the Laboratory :

## PRESCRIPTION 8.

R Fat . . . . .	2.00
Sugar . . . . .	5.00
Proteids . . . . .	1.00
Lime water . . . . .	10.00
To be heated to . . . . .	75° C. (167° F.)

This mixture was given to the infant. In twenty-four hours the number of discharges from the bowels grew less, and in a few days became almost normal. It began to gain in weight, and, though seeming very hungry, looked better and ceased to have colic.

The prescription was then changed to the following one (Prescription 9) :



PRESCRIPTION 9.

R Fat . . . . .	3.00
Sugar . . . . .	6.00
Proteids . . . . .	1.00
Lime water . . . . .	5.00

On taking this food the infant began to make regular gains in weight, but still seemed hungry, so that at the end of another week the prescription was changed to the following one (Prescription 10):

PRESCRIPTION 10,

R Fat . . . . .	4.00
Sugar . . . . .	7.00
Proteids . . . . .	1.50

The infant now improved steadily. It made the normal average daily gains in weight, and soon recovered its color and former strength. From this time it continued to thrive.

This case is interesting in many ways. It was very evident that a percentage of proteids over 3 was more than this especial infant could digest. It therefore had to be weaned from its mother. The wet-nurse's milk, which was agreeing perfectly with her own infant and with another infant which she was nursing at the hospital, had a percentage of proteids between 3 and 4. As I knew from my experience with the mother's milk that this high percentage of proteids would not agree with the infant, I was not surprised to find that, instead of agreeing with it, it made it sick. This case substantiates the statement which I have made in an earlier lecture (Lecture VII., page 180), that, while there are many varieties of good milk, there are also many infants who cannot thrive on them all, but only upon such as suit their individual digestive powers.

It is interesting also to record in this case that, as the infant grew older, it was found that the percentage of the proteids could be increased in its food without harming its digestion, and that by the time it was eight months old it was having in its food percentages of proteids between 3 and 4, the very percentages which caused such serious digestive disturbance when it was younger. When it was ten months old it was able to digest 4 per cent. of proteids in its food.

This case as a whole so well illustrates the use of the Milk-Laboratory that it is hardly worth while to multiply instances of its value. I will, however, give the record of the treatment of some twins (Cases 94 and 95) that have recently come under my charge, showing the utility of feeding by means of modified milk.

These infants were born at term, but were as weak and emaciated as though they had been premature. One of them had a convulsion when it was a few hours old, and the other's circulation was very deficient and showed a cardiac souffle over the base of the sternum for some days. Infants of this class are very apt to die unless their food is carefully regulated at once, and the great lack of equilibrium of the percentages of the elements of the maternal milk in the early days of life is often most disastrous in its effects on the hypersensitive condition of the gastro-enteric tract at this age.

Here is a table (Table 67) showing the condition and the treatment of these infants in the first fifty days of their lives :



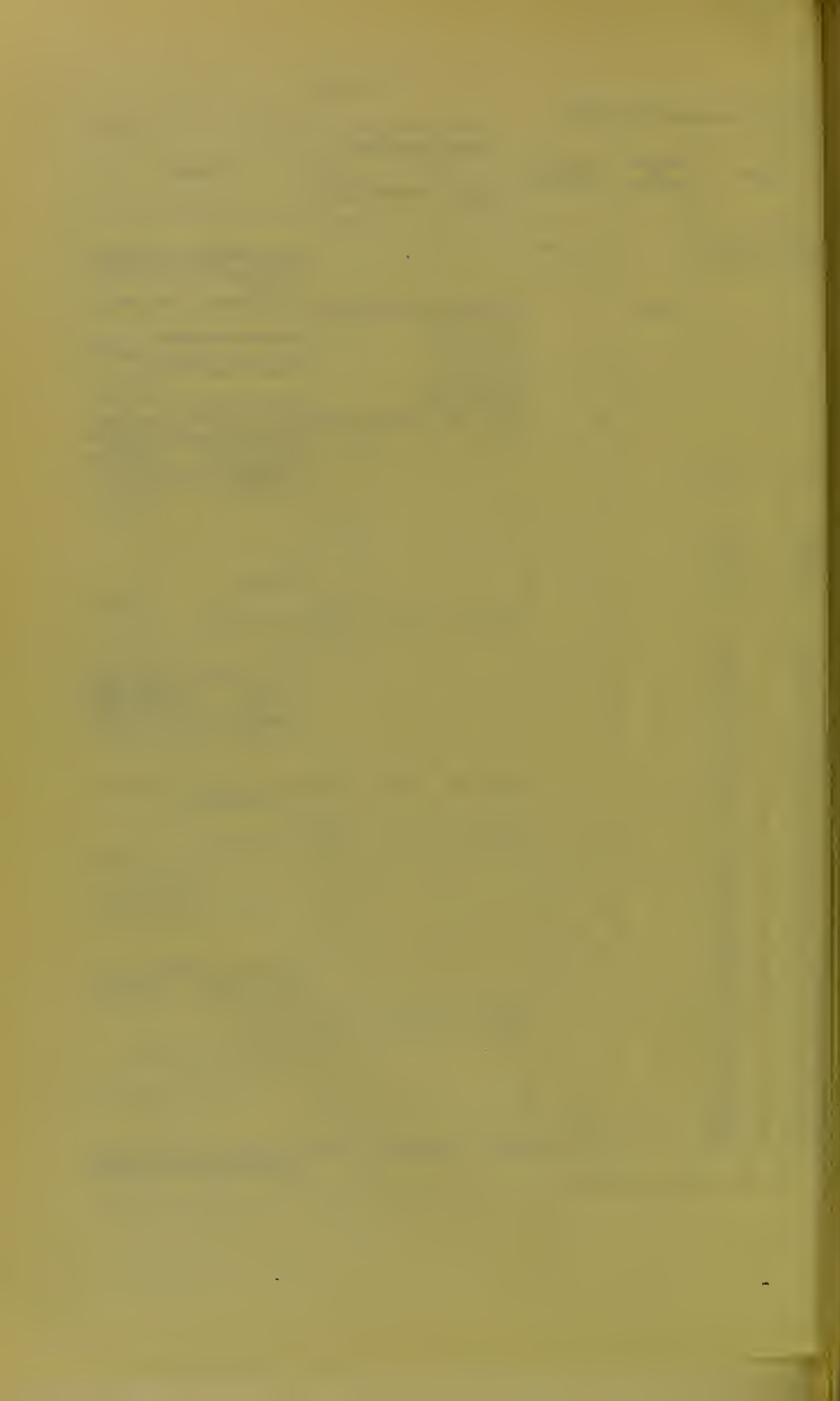
Showing the Details of the First Fifty

REMARKS.	PERCENTAGES OF FOODS.				AMOUNT AT EACH FEEDING.		INTERVALS OF FEEDING.	WEIGHT.		
	Fat.	Sugar.	Proteids.	Lime Water.	C.c.	Dr'ms.		Gram's.	Lbs.	Oz.
Very weak. Emaciated.	.	.	.	.	.	.	.	1816	4	0
Brandy 3 drops every 3 hours.	Equal parts cow's milk and lime water.				4	1	2 hours.	.	.	.
Cardiac murmur at base of sternum.	Breast-milk.				.	.	"	.	.	.
Colic. Loose movements.					16	4	"	.	.	.
Vomiting.					.	.	"	.	.	.
Icterus neonatorum from 8th day to 35th day. Cord fell on 8th day.	Breast omitted.				.	.	"	.	.	.
Brandy 6 drops every 6 hours.	1.50	5.00	0.75	10.00	20	5	"	.	.	.
Very feeble. Respirations irregular.	.	.	.	.	.	.	"	2056	4	8
.	.	.	.	.	.	.	"	.	.	.
.	.	.	.	.	.	.	"	2176	4	12
.	.	.	.	.	.	.	"	2176	4	12
.	.	.	.	.	.	.	"	2270	5	0
.	.	.	.	.	.	.	"	2510	5	8
Vomiting.	.	.	.	.	.	.	"	.	.	.
.	1.25	6.00	0.75	10.00	.	.	"	2630	5	12
.	.	.	.	.	.	.	"	2570	5	10
Much flatus. Six loose green dejections.	.	.	.	.	.	.	"	2540	5	9
Cries a great deal. Very hungry. Brandy 3 drops every 3 hours.	.	.	.	.	32	8	"	2495	5	7½
.	.	.	.	.	.	.	"	2510	5	8
.	.	.	.	.	.	.	"	2510	5	8
.	.	.	.	.	.	.	"	2540	5	9
.	.	.	.	.	.	.	"	2525	5	8½
.	.	.	.	.	.	.	"	2540	5	9
.	.	.	.	.	.	.	"	2555	5	9½
.	.	.	.	.	.	.	"	2525	5	8½
.	1.50	6.00	1.00	10.00	.	.	"	2540	5	9
.	.	.	.	.	.	.	"	2540	5	9
Less vomiting.	.	.	.	.	.	.	"	2495	5	7½
.	2.00	6.00	1.00	5.00	.	.	"	2555	5	9½
Fæcal discharges fewer in number and look better.	.	.	.	.	48	12	"	2600	5	11
.	.	.	.	.	.	.	"	2630	5	12
.	.	.	.	.	.	.	"	2660	5	13
.	.	.	.	.	.	.	"	2660	5	13
.	.	.	.	.	56	14	"	2690	5	14
.	.	.	.	.	.	.	"	2705	5	14½
.	.	.	.	.	64	16	"	2720	5	15
.	.	.	.	.	.	.	"	2739	6½	1½
.	.	.	.	.	.	.	"	2769	6	1½
.	2.50	6.50	1.00	5.00	.	.	"	2724	6	0
.	.	.	.	.	.	.	"	2754	6	1
.	.	.	.	.	.	.	"	2784	6	2
10 feedings in 24 hours.	.	.	.	.	.	.	"	2799	6	2½
.	.	.	.	.	.	.	"	2814	6	3
.	.	.	.	.	.	.	"	2829	6	3½
.	.	.	.	.	.	.	"	2889	6	5½
Fæcal discharges well digested and of good color. Thriving.	3.00	6.50	1.00	5.00	64	16	"	2904	6	6



Life of Cases 94 and 95 (Twins).

WEIGHT.			INTERVALS OF FEEDING.	AMOUNT AT EACH FEEDING.		PERCENTAGES OF FOODS.				REMARKS.
						Fat.	Sugar.	Proteids.	Lime Water.	
ram's.	Lbs.	Oz.		C.c.	Dr'ms.					
1782	3	14	. . . .	. .	. . .	. .	. . .	. . .	. . .	Hemorrhage from cord. Con- vulsions. Very weak. Ema- ciated.
. .	. .	. .	2 hours.	4	1	Equal parts cow's milk and lime water.				Brandy 3 drops every 3 hours.
. .	. .	. .	"	. .	. . .	Breast-milk.				No more convulsions.
. .	. .	. .	"	. .	. . .	Breast-milk.				Colic. Loose fecal dejections.
. .	. .	. .	"	16	4	Breast-milk.				Cord fell on 4th day.
. .	. .	. .	"	. .	. . .	Breast-milk.				
. .	. .	. .	"	. .	. . .	Breast omitted.				Icterus neonatorum from 8th day to 30th day. Less colic.
. .	. .	. .	"	20	5	1.50	5.00	0.75	10.00	Brandy 6 drops every 6 hours.
. .	. .	. .	"	. .	. . .	. .	. . .	. . .	. . .	Very feeble. Respirations irregular. Fewer fecal de- jections.
2056	4	8	"	. .	. . .	. .	. . .	. . .	. . .	
. .	. .	. .	"	. .	. . .	. .	. . .	. . .	. . .	
. .	. .	. .	"	. .	. . .	. .	. . .	. . .	. . .	
. .	. .	. .	"	. .	. . .	. .	. . .	. . .	. . .	
2056	4	8	"	. .	. . .	. .	. . .	. . .	. . .	
2056	4	8	"	. .	. . .	. .	. . .	. . .	. . .	
2176	4	12	"	. .	. . .	. .	. . .	. . .	. . .	
2420	5	4	"	. .	. . .	. .	. . .	. . .	. . .	Vomiting.
. .	. .	. .	"	. .	. . .	. .	. . .	. . .	. . .	
. .	. .	. .	"	. .	. . .	1.25	6.00	0.75	10.00	Less vomiting.
2480	5	7	"	. .	. . .	. .	. . .	. . .	. . .	
2510	5	8	"	. .	. . .	. .	. . .	. . .	. . .	
2480	5	7	"	32	8	. .	. . .	. . .	. . .	Very weak. Icterus pro- nounced. Vomiting occa- sionally. Four or five fecal discharges daily and not well digested.
2495	5	7½	"	. .	. . .	. .	. . .	. . .	. . .	
2480	5	7	"	. .	. . .	. .	. . .	. . .	. . .	
2510	5	8	"	. .	. . .	. .	. . .	. . .	. . .	
2510	5	8	"	. .	. . .	. .	. . .	. . .	. . .	
2495	5	7½	"	. .	. . .	. .	. . .	. . .	. . .	
2510	5	8	"	. .	. . .	. .	. . .	. . .	. . .	
2525	5	8½	"	. .	. . .	1.50	6.00	1.00	10.00	Faecal discharges fewer and better digested.
2510	5	8	"	. .	. . .	. .	. . .	. . .	. . .	
2540	5	9	"	. .	. . .	. .	. . .	. . .	. . .	
2510	5	8	"	. .	. . .	2.00	6.00	1.00	5.00	Very hungry.
2495	5	7½	"	48	12	. .	. . .	. . .	. . .	
2540	5	9	"	. .	. . .	. .	. . .	. . .	. . .	
2570	5	10	"	. .	. . .	. .	. . .	. . .	. . .	
2600	5	11	"	. .	. . .	. .	. . .	. . .	. . .	
2615	5	11½	"	56	14	. .	. . .	. . .	. . .	
2645	5	12½	"	. .	. . .	. .	. . .	. . .	. . .	
2660	5	13	"	64	16	. .	. . .	. . .	. . .	
2675	5	13½	"	. .	. . .	. .	. . .	. . .	. . .	No icterus. Much stronger.
2724	6	0	"	. .	. . .	. .	. . .	. . .	. . .	No vomiting. Faecal dis- charges fewer and look better.
2739	6½	0	"	. .	. . .	. .	. . .	. . .	. . .	
2724	6	0	"	. .	. . .	2.50	6.50	1.00	5.00	
2769	6	1½	"	. .	. . .	. .	. . .	. . .	. . .	
2784	6	2	"	. .	. . .	. .	. . .	. . .	. . .	10 feedings in 24 hours.
2844	6	4	"	. .	. . .	. .	. . .	. . .	. . .	
2874	6	5	"	. .	. . .	. .	. . .	. . .	. . .	
2904	6	6	"	. .	. . .	. .	. . .	. . .	. . .	
2874	6	5	"	. .	. . .	. .	. . .	. . .	. . .	
2919	6	6½	"	. .	. . .	. .	. . .	. . .	. . .	
2949	6	7½	"	72	18	3.00	6.50	1.25	5.00	Faecal dejections well digested and of good color. Thriving.



It may be instructive for you to look over a few of these prescriptions which I have sent to the Laboratory at different times, as they will give you a very fair idea of the simplicity and precision of substitute feeding.

## PRESCRIPTION 11.

*A girl 6 years old; duodenal jaundice (functional).*

R Fat . . . . .	0.50
Milk-sugar . . . . .	6.00
Proteids . . . . .	3 00
Lime water . . . . .	10.00
Send 12 tubes, each 4 ounces.	

## PRESCRIPTION 12.

*A boy 6 weeks old; healthy.*

R Fat . . . . .	3.00
Milk-sugar . . . . .	7.00
Proteids . . . . .	1.50
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).
12 tubes, each 2 ounces.	

## PRESCRIPTION 13.

*A boy 6 months old; healthy.*

R Fat . . . . .	4.00
Sugar . . . . .	7.00
Proteids . . . . .	2.00
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).
8 tubes, each 6 ounces.	

## PRESCRIPTION 14.

*A girl 4 months old; proteid digestion weak*

R Fat . . . . .	4.00
Sugar . . . . .	7.00
Proteids . . . . .	0.75
Lime water . . . . .	5.00
Heated to . . . . .	75° C. (167° F.)
8 tubes, each 4 ounces.	

## PRESCRIPTION 15.

*A boy 6 months old; sugar digestion weak.*

R Fat . . . . .	3.00
Sugar . . . . .	4.00
Proteids . . . . .	2.00
Lime water . . . . .	5.00
Heated to . . . . .	75° C. (167° F.).
8 tubes, each 6 ounces.	

## PRESCRIPTION 16.

*A girl 4 months old; summer diarrhœa. Food has to be sent to a distant town by express.*

R Fat . . . . .	2.00
Sugar . . . . .	5.00
Proteids . . . . .	1 00
At time of each feeding add lime water . . . . .	3 drachms.
Heated to . . . . .	100° C. (212° F.).
20 tubes, each 1 ounce and 1 drachm.	



In this case the diarrhoea had not been sufficiently studied to determine whether it was putrefactive or fermentative, so that a safe general prescription was sent to begin with. The lime water had to be introduced at each feeding on account of the 100° C. (212° F.) heating, necessitated by the hot weather and the distance to be sent. If the lime water had been introduced at the Laboratory and heated to 100° C. (212° F.) with the food, a reaction would have taken place between the lime and the sugar, and the mixture would have turned brown and have had a peculiar taste.

FEEDING OF AVERAGE INFANTS BORN AT TERM.—When an infant is born at term, is of normal development and weight, and is healthy, I am in the habit of regulating the quantity of its food according to the figures which I have arranged in this table (Table 57, page 234). These figures, however, are intended only to be provisional until by experiment the proper amount for the individual has been ascertained.

The quality of the food which I begin with is usually as shown in the following prescriptions (Prescriptions 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29). Where these prescriptions are used the infant is supposed to be digesting well and gaining in weight progressively.

PREScription 17.

*For the first twenty-four to thirty-six hours of life.*

R Milk sugar, five-per-cent. solution, in sterilized distilled water.

PREScription 18.

*First week.*

R Fat . . . . .	2.00
Sugar . . . . .	5.00
Proteids . . . . .	0.75
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

PREScription 19.

*Second week.*

R Fat . . . . .	2.50
Sugar . . . . .	6.00
Proteids . . . . .	1.00
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

PREScription 20.

*Third week.*

R Fat . . . . .	3.00
Sugar . . . . .	6.00
Proteids . . . . .	1.00
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

PREScription 21.

*Four to six weeks.*

R Fat . . . . .	3.50
Sugar . . . . .	6.50
Proteids . . . . .	1.00
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

## PRESCRIPTION 22.

*Six to eight weeks.*

R Fat . . . . .	3.50
Sugar . . . . .	6.50
Proteids . . . . .	1.50
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

## PRESCRIPTION 23.

*Two to four months.*

R Fat . . . . .	4.00
Sugar . . . . .	7.00
Proteids . . . . .	1.50
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

## PRESCRIPTION 24.

*Four to eight months.*

R Fat . . . . .	4.00
Sugar . . . . .	7.00
Proteids . . . . .	2.00
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

## PRESCRIPTION 25.

*Eight to nine months.*

R Fat . . . . .	4.00
Sugar . . . . .	7.00
Proteids . . . . .	2.50
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

## PRESCRIPTION 26.

*Nine to ten months.*

R Fat . . . . .	4.00
Sugar . . . . .	7.00
Proteids . . . . .	3.00
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

## PRESCRIPTION 27.

*Ten to ten and a half months.*

R Fat . . . . .	4.00
Sugar . . . . .	5.00
Proteids . . . . .	3.25
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

## PRESCRIPTION 28.

*Ten and one-half to eleven months.*

R Fat . . . . .	4.00
Sugar . . . . .	4.50
Proteids . . . . .	3.50
Reaction . . . . .	Slightly alkaline.
Heated to . . . . .	75° C. (167° F.).

## PRESCRIPTION 29.

*Eleven to eleven and one-half months.*

R Unmodified cow's milk.

At about the tenth or eleventh month I usually begin to give at first one and then two meals daily of equal parts of oat jelly, prepared at the Laboratory, with plain cow's milk heated to 75° C. (167° F.), and a little salt added according to the infant's taste at the time of the feeding. (Preparation of cereals described in Lecture X., p. 281.) Freshly prepared barley or wheat can, if preferred, be given with milk at this age.

In the twelfth month I usually accustom the infant to taking a little bread one day old with its milk, and to be fed from a spoon, so that by the time it is a year old it is taking bread and milk for its breakfast and supper, and oat jelly and milk for the three middle meals.

COLOR OF FÆCAL DEJECTIONS AS INFLUENCED BY THE PERCENTAGE  
OF FAT IN THE FOOD.

I have considered it of some scientific interest to record the color of the faecal discharges which corresponds apparently to the percentage of fat in human milk and in the corresponding modified milk. On these two napkins (Plate III., 3 and 4, facing p. 112) are the normal yellow dejections of two infants (Cases 96 and 97) who are being nursed by their healthy mothers and are themselves digesting well and thriving.

Here are also two napkins (Plate III., 8 and 9, facing p. 112) on which are the normal yellow dejections of two infants (Cases 98 and 99) who are being fed on a modified milk which is supposed to correspond to average human milk. The percentages of the fat, sugar, and proteids in this modified milk are respectively 4, 7, and 1. The infants are digesting well and thriving.

You will notice the striking resemblance in color and consistency between these faecal discharges resulting from human milk and from modified milk, where the percentage of fat is 4.

I have here also to show you the faecal discharges (Plate III., 7, facing p. 112) of a healthy infant (Case 100), fed on a modified milk having a percentage of 3 for its fat, 6 for its sugar, and 1 for its proteids. You see how much lighter the color of the yellow is.

This change of color is still more strikingly illustrated in this napkin taken from this fourth infant (Case 101, Plate III., 6, facing p. 112), where its modified milk was composed of fat 2 per cent., sugar 5 per cent., and proteids 1 per cent., and where you see the resulting faecal discharge has a very much lighter yellow color than is the case with the others.

During the last three years I have been able to test the value of this Laboratory by the feeding of nearly three thousand infants, and my experience has been controlled in the practical use of this system by about four hundred physicians. The number of infants that have been fed from the Laboratory each day was about two hundred.



I myself believe that by the establishment of these laboratories a new era has been entered upon in the province of infant feeding, and one which will enable us to produce results which have never before been obtained.

Before leaving the subject of milk-laboratories, I should like to impress upon you that the establishment of laboratories for the modification of milk has to so great a degree been accomplished by the extensive knowledge of the subject, the great experience, the unwavering determination, and the enthusiastic efforts of Mr. G. E. Gordon, that physicians, as well as all others who are interested in the welfare of infants, must always acknowledge their indebtedness to him for the great work which he has carried to so successful an issue.

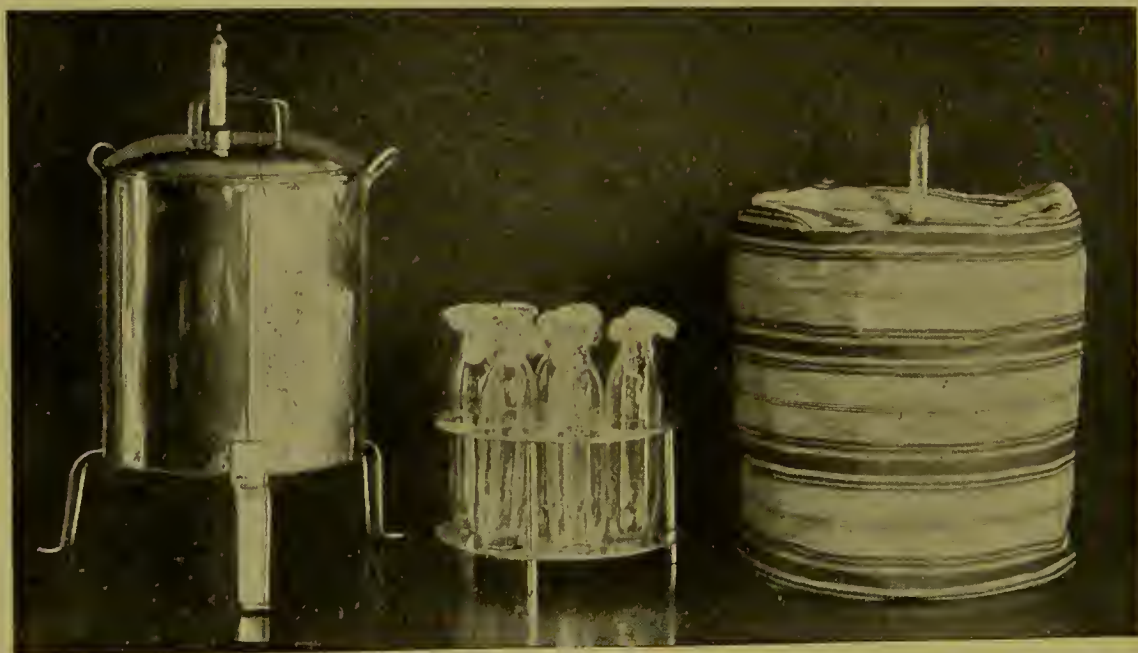
The first milk-laboratory for the exact modification of milk that has been established in the world is the one which I have just shown you, and was opened to the public in 1891 here in Boston, under the name of the Walker-Gordon Laboratory.

## LECTURE X.

## HOME MODIFICATION.—GENERAL REMARKS ON ARTIFICIAL FOODS FOR INFANTS.

**HOME MODIFICATION.**—I think that you will now agree with me that the importance of modifying milk with the most exact precision is self-evident if we expect to perfect a substitute food. Many persons are not near enough to milk-laboratories to have their infants' food prepared by this means. It is therefore necessary to provide for the preparation of the food for this class of cases in their homes. Under these circumstances I have, in conjunction with Mr. Gordon, made a recent study of the best means to accomplish this end, and I will describe them under the term of "Home Modification." I presuppose that absolute simplicity as to the materials used and such as can be obtained easily is necessary, and also that the method employed should be such as any physician can explain to a mother of ordinary intelligence.

FIG. 68.



Sterilizer and thermometer.      Stand for tubes.      Sterilizer covered with cozy after removal from heat.

**MATERIALS.**—I have here to show you the materials which will make possible the home modification of milk for substitute feeding with an accuracy closely approximate, though not equal, to that of the Laboratory. All this apparatus and the same feeding-tubes that I have already described can be procured at the Laboratory for the original outfit.

**Home Sterilizer.**—This is what is called the "Home Sterilizer" (Fig. 68). It is simply a tin can supported on legs so that it can be heated by a

lamp, or, if preferable, the legs can be removed and the can placed on a stove.

**Thermometer.**—It has a lid, to which is fitted a thermometer by which the degree of heat within the can is indicated.

**Tubes.**—The tubes, varying in number according to the number of feedings which are required in twenty-four hours, are placed in this stand, which can be lowered into the sterilizer and be immersed in the water in the sterilizer, which is made to rise as high as the level of the milk in the tubes.

**Stoppers.**—You see that the tubes are stoppled with cotton-wool, according to the usage at the Laboratory.

**Cozy.**—I have also here another sterilizer, which has been covered with a thick cozy, through which the thermometer from the lid passes and indicates the degree of heat retained within the sterilizer after the flame has been removed.

**Graduate.**—The other articles to be procured at the Laboratory are this 250 c.c. ( $8\frac{1}{2}$  ounces) glass graduate (Fig. 55, p. 251), divided, as you see, into half-drachms.

**Cotton-Wool.**—Also a roll of aseptic non-absorbent cotton-wool.

**Milk-Sugar.**—Also some milk-sugar.

**Sugar-Measure.**—Also this sugar-measure, which holds 13.5 grammes ( $3\frac{3}{8}$  drachms).

FIG. 69.



Sugar-measure.

This measure obviates the expense of having the milk-sugar put up in packages by the apothecary, and is sufficiently exact to regulate the sugar percentage in the mixtures which I shall speak of presently. It is well to remember, however, that a pound of milk-sugar contains 464 grammes (7000 grains), and that if you prefer to order the sugar in packages of 13.5 grammes ( $3\frac{3}{8}$  drachms) directly from the apothecary, in place of using the measure, you can simply tell him to make thirty-five packages from the pound, and you can then direct a package of milk-sugar to be used instead of a measureful.

**Siphon.**—Finally, they must have this glass siphon (Fig. 70), 0.6 em. ( $\frac{1}{4}$  inch) calibre. The siphon can be used in any quart glass jars which the family happen to have.

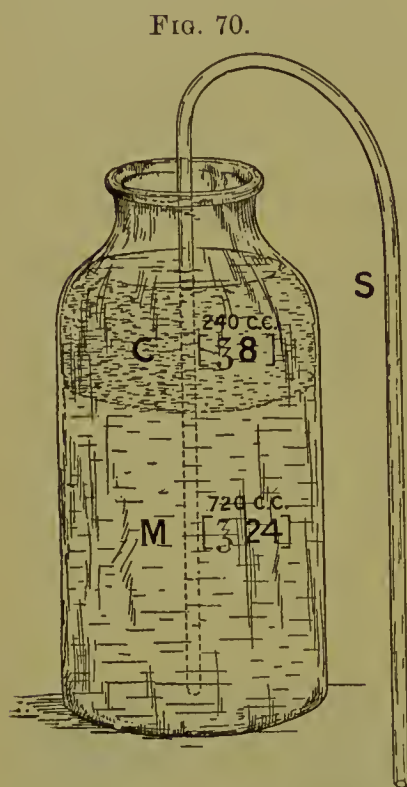
The siphon should be a glass tube one-quarter to one-half inch in diameter. It can be bent in a gas-flame. The end out of which the milk is to flow should be at least six inches longer than that which is to be inserted in the jar. To operate the siphon, fill it with boiled water, close the longer end with the finger, invert the siphon, and place the shorter end in the milk. Then withdraw the finger, and the water, followed by the milk,



will run out of the long arm of the siphon. Do not use the mouth to start the flow of the milk through the siphon, under any circumstances.

The mother is to be told that extreme precautions are to be taken to follow your directions to the minutest detail, or otherwise a uniformly cor-

rect result will often be lost. You must explain that the milk from a herd of cows is preferable to that of one cow, for many reasons, but especially because the elemental percentages are less likely to vary in the mixed milk of a herd than in that of the individual, and because the mixing lessens the deleterious effects on the milk arising from occasional disturbance of health in an individual member of the herd. The cows should be of a common breed, and such as give a moderately rich milk. The milk should be drawn with clean hands. The udders and teats of the cows should be cleansed, and the cows should be milked in as clean a place as possible. The milk should be thoroughly strained. You will now have a milk fairly uniform in its elemental percentages and comparatively free from bacteria and foreign matter. The composition of this milk will usually correspond to that which you see in this table (Analysis 40, page 218). The milk



Jar containing milk, cream, and siphon. C, cream; M, milk; S, siphon.

is then set in a vessel containing ice and water with some salt, in the proportion of 5 grammes (1 teaspoonful) to 960 c.c. (1 quart) of water, and the vessel is set in some clean place.

(Dr. Seibert, of New York, has recommended a system of filtering through a funnel containing aseptic cotton, and asserts that the bacteria are reduced in numbers one-half by this procedure. The fats, however, according to my experience in the use of this method, are also somewhat reduced, though not to any great degree. With the precautions taken, such as I have just stated for obtaining the milk-supply, the cotton filter will probably not be necessary, but it can be used, as Seibert intends it to be, where there are known to be much dirt and many bacteria in the milk. Dr. Seibert has had carefully prepared cotton disks and funnels made for filtering milk in this way.)

You should always endeavor to prevent impurities from getting into the milk in preference to trying to eradicate them after they have begun to alter the normal composition of the milk.

A clean, freshly boiled cotton cloth is next thrown over the uncovered quart jar. The mouth of the jar is kept open for about fifteen minutes, to dispose of the animal heat. The jar is then sealed tightly, as you would do for preserving, and is left in the ice-water for six hours, care being taken

that the temperature of the water does not fall below  $1.66^{\circ}$  C. ( $35^{\circ}$  F.). At the expiration of six hours you are to siphon out carefully from the bottom of the jar with this siphon (Fig. 70, page 278) 720 c.c. (24 ounces) of the milk into a clean glass vessel.

You will now have your various materials ready for any combinations which you may wish to make in preparing the food for an especial infant. These materials are: the milk which you have siphoned from the jar, the cream containing ten per cent. of fat which remains in the jar, the sugar, either in packages as I have just described or in bulk, to be used when needed with the sugar-measure, some fresh lime water, and some clean drinking-water which has been boiled for five minutes.

I have arranged in these tables (Tables 68 to 80) figures by means of which you can make the various combinations which you will be likely to need, and which correspond somewhat to the prescriptions that I have already shown you at the Laboratory:

TABLE 68.

Fat . . . . .	0.25
Sugar . . . . .	4.00
Proteids . . . . .	0.25
Lime water . . . . .	5.00

To obtain this combination with our materials, and to provide a sufficient quantity of food to last for twenty-four hours, you should give the following orders.

Set enough milk to raise cream sufficient for the mixture required. For each twenty ounces, or part of twenty ounces, use the following formulæ:

Cream . . . . .	$\frac{1}{2}$ ounce.
Milk . . . . .	1 ounce.
Lime water . . . . .	1 ounce.
Water . . . . .	$17\frac{1}{2}$ ounces.
	<u>20 ounces.</u>
Milk-sugar . . . . .	2 measures.

The milk-sugar is to be thoroughly dissolved in the water of the mixture before the other materials are added.

TABLE 69.

Fat . . . . .	1.00	Cream . . . . .	2 ounces.
Sugar . . . . .	5.00	Milk . . . . .	2 ounces.
Proteids . . . . .	0.75	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	<u>15 ounces.</u>
			20 ounces.
		Milk-sugar . . . . .	2 measures.

TABLE 70.

Fat . . . . .	2.00	Cream . . . . .	4 ounces.
Sugar . . . . .	5.00	Milk . . . . .	None.
Proteids . . . . .	0.75	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	<u>15 ounces.</u>
			20 ounces.
		Milk-sugar . . . . .	2 measures.

TABLE 71.

Fat . . . . .	2.00	Cream . . . . .	4 ounces.
Sugar . . . . .	5.50	Milk . . . . .	1½ ounces.
Proteids . . . . .	1.00	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	13½ ounces.
			20 ounces.
		Milk-sugar . . . . .	2¼ measures.

TABLE 72.

Fat . . . . .	2.50	Cream . . . . .	5 ounces.
Sugar . . . . .	6.00	Milk . . . . .	None.
Proteids . . . . .	1.00	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	14 ounces.
			20 ounces.
		Milk-sugar . . . . .	2½ measures.

TABLE 73.

Fat . . . . .	3.50	Cream . . . . .	7 ounces.
Sugar . . . . .	6.50	Milk . . . . .	1 ounce.
Proteids . . . . .	1.50	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	11 ounces.
			20 ounces.
		Milk-sugar . . . . .	2½ measures.

TABLE 74.

Fat . . . . .	4.00	Cream . . . . .	8 ounces.
Sugar . . . . .	7.00	Milk . . . . .	None.
Proteids . . . . .	1.50	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	11 ounces.
			20 ounces.
		Milk-sugar . . . . .	2¾ measures.

TABLE 75.

Fat . . . . .	4.00	Cream . . . . .	8 ounces.
Sugar . . . . .	7.00	Milk . . . . .	2½ ounces.
Proteids . . . . .	2.00	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	8½ ounces.
			20 ounces.
		Milk-sugar . . . . .	2½ measures.

TABLE 76.

Fat . . . . .	4.00	Cream . . . . .	8 ounces.
Sugar . . . . .	7.00	Milk . . . . .	5 ounces.
Proteids . . . . .	2.50	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	6 ounces.
			20 ounces.
		Milk-sugar . . . . .	2¼ measures.

TABLE 77.

Fat . . . . .	4.00	Cream . . . . .	8 ounces.
Sugar . . . . .	7.00	Milk . . . . .	7½ ounces.
Proteids . . . . .	3.00	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	3½ ounces.
			20 ounces.
		Milk-sugar . . . . .	2 measures.



TABLE 78.

*For weaning.*

Fat . . . . .	4.00	Cream . . . . .	8 ounces.
Sugar . . . . .	5.00	Milk . . . . .	7½ ounces.
Proteids . . . . .	3.00	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	3½ ounces.
			<u>20 ounces.</u>
		Milk-sugar . . . . .	1 measure.

TABLE 79.

*For weaning.*

Fat . . . . .	4.00	Cream . . . . .	8 ounces.
Sugar . . . . .	5.00	Milk . . . . .	8 ounces.
Proteids . . . . .	3.25	Lime water . . . . .	1 ounce.
Lime water . . . . .	5.00	Water . . . . .	3 ounces.
			<u>20 ounces.</u>
		Milk-sugar . . . . .	⅞ measure.

TABLE 80.

*For weaning.*

Fat . . . . .	4.00	Cream . . . . .	8 ounces.
Sugar . . . . .	4.50	Milk . . . . .	12 ounces.
Proteids . . . . .	3.50		<u>20 ounces.</u>

After the various materials have been mixed, in the proportions which I have shown you in these tables, the mixture is prepared for the "home sterilizer." The requisite amount of food for one feeding is poured into each of the tubes. They are stoppled with cotton-wool, care being taken to have a reasonably tight stopple in and a dry neck to the tubes. The tubes are then placed in the rack and lowered into the sterilizer, and the water in the sterilizer is adjusted to the level of the milk in the tubes. Heat, by means of a lamp or stove, is then applied to the sterilizer, which is watched, with the cover off, until the thermometer shows that the water-bath has reached a point of 77.2° C. (171° F.). The lamp is removed as soon as this temperature is reached, the cover put in place, and the cozy over it. The thermometer should mark a temperature of between 75° C. (167° F.) and 77.6° C. (170° F.) for thirty minutes, at the expiration of which time the tubes are to be removed from the sterilizer, and are to be kept in a cool place, preferably the ice-chest, until needed.

**OATS.**—For the preparation of oat jelly the following method should be employed :

120 grammes (4 ounces) of coarse oatmeal are allowed to soak in a quart of cold water for twelve hours. The mixture is then boiled down so as to make a pint, and is strained through a fine cloth while it is hot.

When it cools, a jelly is formed, which is to be kept on ice until needed. Different proportions of this jelly can be used, but usually it is best to begin with equal parts of jelly and cow's milk. When needed, this mixture is warmed and a little salt is added.

**BARLEY.**—Barley water is made by boiling 150 grammes (5 ounces)

of granulated barley in a quart of water until the volume is reduced to a pint, and then straining.

If a barley jelly is to be made, 120 grammes (4 ounces) of barley flour are employed, and the same process is gone through with as for the preparation of oat jelly. The resulting jelly is treated in the same way with milk as I have directed for oat jelly.

**WHEAT.**—Wheat can be prepared by the same method as that described for oats and barley.

**PEPTONIZED MILK.**—For peptonizing milk, the following rules are the most practical and simple:

In a clean glass jar containing 4 ounces of cold distilled or boiled water dissolve 1 gramme (15 grains) of bicarbonate of soda and 0.25 gramme (5 grains) of pancreatine (*extractum pancreatis*), to which add 12 ounces of whole milk. Set the jar in a vessel of water at a temperature of 41.6° C. (107° F.) for from seven to ten minutes. Cool immediately, and keep on ice until used.

To peptonize modified milk an amount of the powders should be used corresponding with the percentage of the proteids in the mixture, taking the standard of whole milk to be represented by four per cent. of the proteids.

**SWEET WHEY.**—Sweet whey is best made by the following method:

For each pint of whey needed take one quart of whole fresh milk, heated to 37.7° C. (100° F.), to which add 8 c.c. (2 drachms) of the essence of pepsin, or one square inch of rennet. When the proteids have been precipitated, break the curd finely with a fork, and pour off the fluid, straining it through two thicknesses of boiled cheese-cloth.

This removes such of the proteids as are coagulable by acids.

Place this strained liquid in a clean porcelain pot, and raise the temperature to the boiling-point by a stove or a lamp, but do not allow it to boil. Strain this hot liquid through a cloth as before.

This removes the proteids coagulable by heat.

Cool the resulting fluid slowly to a temperature of 10° C. (50° F.), and keep on ice until needed.

**ARTIFICIAL FOODS FOR INFANTS.**—It would seem hardly necessary to suggest that the proper authority for establishing rules for substitute feeding should emanate from the medical profession, and not from non-medical capitalists. Yet, when we study the history of artificial feeding as it is represented all over the world, the position which the family physician occupies, in comparison with that of the venders of the numberless patent and proprietary artificial foods administered by the nurses, is a humiliating one, and should no longer be tolerated.

If we are abreast of the times, if we but recognize and do justice to the work which has lately been done by our own profession, we surely will not hesitate to relegate to oblivion the statements of the food proprietors, which on box and can, on bottle and printed circular, attempt to stem the slow but inevitably progressing wave of scientific investigation.



It may be well to bear in mind that the attempts which in the past have been made to manufacture cheap foods have been markedly failures. We must first, regardless of expense, learn to produce by modification a perfected substitute food, and not endanger the success of our undertaking by allowing the mercantile side of the question to cripple us in the use of costly methods, which, however, we know to be the best. We should, in fact, remember that the human milk, which we are endeavoring to copy, far from being a cheap product, is a very expensive one.

My own opinion in regard to patent foods, as a whole, is that they must necessarily be unreliable. They are thrown on a market where the competition is extreme, and when once they have been advertised into public notice I cannot but feel that irregularities and changes—slight, perhaps, in the eyes of the makers—may unintentionally creep in and carry their composition still further from that of the standard, human milk.

Analyses show that there is a lack of uniformity in these foods from year to year, and that original claims are apparently forgotten or allowed to give way to cheaper production. In fact, as my experience in the feeding of infants increases, and as I examine year by year the effects of the different foods on infants, I am strongly impressed with the belief that with our present physiological, chemical, and clinical knowledge all the patent foods are entirely unnecessary. The claims made for them are not supported by intelligent and unprejudiced investigation. Those who manufacture them are not in a position to judge correctly concerning them. The merit at times of their apparent success does not belong to them, but to accompanying circumstances. They do great harm by impressing upon the public the false idea that a cheap, easily prepared food is for the good of the infant and is better than anything which can be procured elsewhere. They vary too greatly in their analyses to keep even within the acknowledged varying limits of human milk. It is therefore high time for physicians to appreciate exactly how inefficient in themselves and how misleading in their claims are these artificial foods, and also in what a false position, as the protector of and adviser to the public, our profession is placed whenever it lends itself to even a toleration of their use. I speak of them here simply because there is no doubt that they are kept in the market by the physician rather than by the manufacturer. The latter is only doing what any capitalist interested in a business venture would do. The former, it seems to me, is, perhaps unintentionally, aiding the business interests of others at the expense of his own future reputation as a scientist. It makes little difference to physicians as to what is claimed for these foods when they are placed in the market. It makes a great difference what the mixture contains when given by the mother to the infant according to the directions on the label. For instance, a food may show by its published and certified analysis a fair percentage of fat or sugar, and yet this same food when diluted for the infant's feeding may have these constituents reduced far below the reasonable limits of nutrition.



## LECTURE XI.

## THE SECOND AND THIRD NUTRITIVE PERIODS.

**SECOND NUTRITIVE PERIOD.**—During the eleventh and twelfth months of life the amylolytic function of the infant has become almost fully developed. In accordance with the rule regarding the use of the different functions, which I have already spoken of,—namely, that a function should not be taxed before it is developed, but that when its development is almost completed it should be brought into use,—we should in the latter part of the first year begin to use that function of the digestive tract by means of which the amylaceous elements of the food are converted into sugar.

In speaking of weaning I have already explained to you the value of using preparations of oats or barley mixed with milk. I have also shown you how to reduce gradually the percentage of sugar in the modified milk which is being given at the tenth and eleventh months and at the same time to increase the percentage of the proteids. The reason for changing the relative percentages of these elements is that the power to digest proteids has much increased during the latter part of the first year. The capacity for digesting a high percentage of sugar is just as great at this period as at an earlier one, but the amount of sugar, given directly as such, which is required in the later is not so great proportionately as in the earlier period. A large portion of the sugar which is needed for nutrition in this later period is intended to be introduced into the economy by means of a new element in the food,—starch. A certain amount of sugar is, as before, directly introduced into the gastro-enteric tract from the milk-sugar of the milk, and the starch when converted into sugar supplies the remaining portion of sugar needed for nutrition. In a normal infant with normal digestive functions a considerable percentage of starch can be digested and absorbed with benefit in the eleventh and twelfth months.

I am therefore in the habit of giving preparations of oats or barley when I have decided that starch should be introduced into an infant's food. There is a larger percentage of starch in oats than in barley. It is also more nutritious in every respect, as it contains a considerable percentage of fat. The starch in oats takes a somewhat longer time to be converted into sugar than does that of barley, so that in the case of an infant whose amylolytic function is not fully developed or is somewhat weak, preparations of barley will be better to begin with, because they do not introduce so high a percentage of starch into the food, and also because the starch will be more readily converted into sugar. Preparations of oats seem to be the best form of food to be added to the modified milk when the

infant has reached a period at which it needs a change in the character of its food.

When the infant has reached the third or fourth month of its life it normally should be able to digest four per cent. of fat in its food. This percentage of fat corresponds, as I have already shown you, to that which exists in average cow's milk. It is natural to suppose that at the eleventh and twelfth months a still further increase in the amount of fat which is provided in the infant's food is required, as well as the new element, starch. This fat is supplied, as I have already told you, in considerable quantity from the oats.

We have therefore, in preparations of oats, both for purposes of weaning and for establishing a new regimen of diet for the infant, a food which in combination with cow's milk satisfies completely the demands which the digestive functions at this period are making for a perfect nutriment.

The second nutritive period may be reckoned to last from the twelfth to the twenty-eighth or thirtieth month of life. That is about the second half of the period which we are in the habit of calling infancy. It also includes the time when the last four teeth of the first set appear. In this second nutritive period the element of variety in the food becomes important. It is undoubtedly important that the actual nutritive values of the food which it is best to give to infants in this period be considered, but it is much more important that special attention be paid to its variety. Foods should be given which while containing a fair percentage of nutritive elements yet differ in the combination of these elements to such a degree that they fulfil the requirements of this period of life. It is best to increase gradually the variety of articles of diet from the twelfth to the twentieth month, always adapting the food to the especial infant. Thus, some infants may be able to digest and assimilate proportionately large quantities of starch; others may both need and digest larger proportions of the proteids or of sugar than the infants first spoken of.

Between the twelfth and thirteenth months I am in the habit of giving the infant five meals during the day. At this time it is well to accustom it to take its food from a spoon, and as soon as possible to omit feeding from the bottle. The five meals should be arranged in the following manner:

For breakfast, bread and cow's milk, slightly warmed.

For lunch, equal parts of oat jelly and cow's milk, warmed, with a little salt added according to the infant's taste.

This meal of oat jelly should be repeated in the middle of the afternoon.

In the middle of the day, broth of some kind, either chicken or mutton, carefully prepared so as to be free from fat on its surface, can be given with some bread.

The fifth meal should be given in the latter part of the afternoon, and should consist of bread and milk.

In some cases it is impossible to make infants swallow bread for a



long period after the usual time of twelve to thirteen months. At times it is not until they are two and one-half to three years old that they can be induced to take bread. In these cases we must feed them according to our judgment of the individual case.

When the infant is fourteen to fifteen months old, some thoroughly boiled rice can be added to the broth in the middle of the day, and if it digests this well it can also have bread given with this meal.

When the infant is sixteen months old, it can have a small amount of butter on its bread. When it is seventeen to eighteen months old, it can have a thoroughly baked white potato, mixed with butter and salt, added to its mid-day meal of broth. When it is nineteen to twenty months old, eggs can become part of its diet.

There are not many fruits which should be given to the infant in its second year. A baked apple can be given at the evening meal when the infant is fourteen to fifteen months old; or, for variety, the apple can be made into a simple sauce, never, however, having the sauce made with much sugar. When peaches are in season, a ripe peach can often be given with benefit, especially if the infant is inclined to be constipated. Other fruits should be avoided, as they are not necessary for the infant's nutrition and at times produce serious trouble.

This is the diet which is sufficient for the infant during the second nutritive period. It is important for the subsequent integrity of the infant's digestion and general nutrition that the parents should insist that no other articles of food be employed, except such as are similar to those which I have spoken of,—namely, the cereals in a variety of forms, according to the taste, judgment, and knowledge of cooking which exists in the special household. For instance, preparations of wheat and barley cooked in various forms may be given in place of oatmeal. Bread also in different forms may be given. The crust of French bread is easily digested, and is supposed to have less starch in proportion to its gluten than the usual home-made bread. It is well to begin with some form of bread of this kind when we are getting the infant accustomed to take starch in the form of bread. If it is constipated, Graham bread and preparations of rye will also be found useful. Fresh bread should never be given, and bread one day old is the preferable form which should be provided.

The infant should never be given cake or candy even to taste. I think that it is necessary to state this very decidedly, because it is an erroneous view which is held by most mothers that it can do no harm to give occasionally to an infant in its second year of life, or to a young child, a little candy or a little cake. This may be true so far as the immediate effect these articles may have on the digestion is concerned, but it is of far more importance that the infant should not have its taste perverted from those articles of diet which are best for its nutrition. These new articles appeal more strongly to its sense of taste, and allow it to know that there is something which tastes more agreeable than the food which it is accustomed to have. When



an infant has acquired a taste for cake or candy, it will cease to enjoy the food by which its development will be best perfected. It is, in fact, kinder to the infant never to allow it to taste cake or candy. When these articles are withheld, it will continue to have a healthy appetite and taste for necessary and proper articles of food.

I am so often asked by mothers what is the best method of preparing simple broths for their infants that perhaps it may be well for you to know how these broths should be made.

**CHICKEN BROTH.**—A fowl weighing about five pounds should be boiled for about twelve hours. The fluid should be strained while hot through a fine sieve. It should then be allowed to cool in an earthen jar for about twelve hours in the ice-chest. The resulting jelly can be used in full strength or diluted with water. When the jelly has been thoroughly cooled, the fat can be either partially or entirely removed from the top.

**MUTTON BROTH.**—A shoulder of lamb, when it can be obtained, —otherwise of mutton,—weighing from five to seven pounds, is treated in the same way as is the fowl for the preparation of chicken broth.

**THE THIRD NUTRITIVE PERIOD.**—The third nutritive period I have arbitrarily made to begin at about the thirtieth month of life.

At this time it will be well to begin to accustom the child's digestive functions to a still greater variety of food. In summer the more easily digestible vegetables, such as squash, young peas, and young beans, can be given. The variety of fruits can also be increased at this period, but they should be cooked. The principal change which is to be made in the diet to which the infant has been accustomed is a very decided increase in the proportion of the proteid element of its food. This is accomplished by means of giving the child meat. The quantity of meat which should be given towards the end of the third year should be small at first, and should be given at intervals of a day or two. Meat as a regular article of diet for each day is not, as a rule, required until the child is between three and four years old. The kinds of meat which should be given in this early period of childhood are chicken, mutton-chop, roast beef, and beefsteak. These meats should be cut into small pieces, and a little salt added according to the child's taste. It is well, during the latter part of the third year and the first half of the fourth year, to give the child an egg on one day and meat on the next.

When the child has reached the age of five or six years, we should allow it to have a somewhat more varied diet, but during the whole period of childhood up to the age of puberty the closest attention should be given to the regulation of the kind and the amount of food to be given to the child, and any deviations from the rules which I have just laid down are to be deprecated.

## DIVISION V.

### PREMATURE INFANTS.

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#### LECTURE XII.

I SHALL next speak of that class of infants which is designated as premature, because they are born prior to the usual two hundred and eighty days which represent the normal duration of intra-uterine life. I describe this class of cases directly after what I have just told you about infant feeding not only because it is essentially the proper management of the food which preserves the lives of these infants, but because I consider that the best way to feed premature infants is by means of food carefully prepared at milk-laboratories. This method of feeding premature infants is far superior to even breast-feeding, and, in my opinion, the use of milk-laboratories in these cases will result in a decided reduction in their mortality.

Very few cases are reported, and none of them appear to be absolutely authentic, where an infant has survived which was born much before the twenty-seventh or twenty-eighth week of intra-uterine life. The premature infant in its intra-uterine development is unprepared to meet the conditions of extra-uterine life, and often dies within a few days, and usually within a few hours.

A sufficient number of careful investigations regarding the characteristic appearances and the development of the foetus during the last four months of intra-uterine life has not yet been made and recorded to enable us to state definitely what age the infant represents when it is born. The few facts which we possess concerning this subject must, however, be made use of, and, though not absolutely correct, are sufficiently so to be of great value to us in our management of these cases. One reason for the difficulty which arises in every case in determining the age of the foetus is that the conditions which influence its growth during intra-uterine life are very varied. The health of the mother and her hygienic surroundings, together with the influence of heredity on the size of her offspring, present good reasons for decided variations in the growth of the foetus in different cases at the same period of intra-uterine life.

If the infant is living when it is born, we should at once carry out the



rules for preserving its life which have proved to be best in the case of any infant born prematurely. These rules should be insisted on even if the infant has been born at a much earlier stage of development than is, according to our present ideas, compatible with its viability. This is necessary, because so many errors in our calculation as to when the impregnation took place are liable to arise, and also because a foetus may have arrived at a period of intra-uterine development which is perfectly compatible with life, and yet from its small weight and general characteristics have the appearance of one whose development is incompatible. Whatever advances we may make in the future in preserving the lives of premature infants born at an earlier date than is supposed to be compatible with life,—namely, from the twenty-fourth to the twenty-eighth week,—it would hardly be practical at this time to discuss the treatment of infants born before the twenty-fourth week.

**TWENTY-FOUR WEEKS.**—A foetus born at about the twenty-fourth week of intra-uterine life usually breathes feebly, and dies in the course of a few hours, apparently from an inability to accommodate itself to conditions for which it is not prepared. At this stage of development it may still have fine hair (lanugo) over the whole of its body, but it is often the case that this hair, commonly found from the sixteenth to the twentieth week, has disappeared. At this age it still has very little deposition of fat in the subcutaneous cellular tissue, and it has a decidedly emaciated appearance. In other respects, except its size, it does not differ very much in its appearance from the foetus of some weeks' later development. Its eyelids have separated, though it is so feeble that, as a rule, it cannot open and shut them.

The estimation of the length of the foetus is difficult to make, and, on the whole, unsatisfactory and inexact. These measurements, in all probability, differ very much when made by different investigators, owing, as Minot has pointed out, to the many changes in the curvature of the longitudinal axis of the human embryo, which make it impracticable to employ any one system of measurement in obtaining comparable results for all ages. Hecker's figures, however, are probably as reliable as any we know of. According to this author, at about the twenty-fourth week the foetus measures 28 to 34 cm. ( $11\frac{1}{4}$  to  $13\frac{1}{2}$  inches). Its weight, according to Lusk, is about 690 grammes (23 ounces).

**TWENTY-EIGHT WEEKS.**—By the time the foetus has reached the twenty-eighth to the twenty-ninth week of intra-uterine existence its condition, so far as its development is concerned, is such that there is no necessary contra-indication to its living if it happens to be born at this time. It has been stated that an infant born prematurely at the twenty-eighth week is more likely to live than one which is born at the thirty-second week of intra-uterine life, and that this has been proved by statistics. If true, the reason for this, I believe, is because much greater care is taken of the former than of the latter. It is reasonable to believe that an earlier stage



of intra-uterine development is less likely to insure continuance of life after premature birth than a later stage, provided the same precautions are taken in each case.

Hecker's and Lusk's figures, in a general way, state that when the foetus is born at about the twenty-eighth to the twenty-ninth week it measures from 35 to 38 cm. (about  $13\frac{3}{4}$  to 15 inches) and weighs about 1170 grammes (39 ounces). The skin is still wrinkled, is of a dull red color, is covered with vernix caseosa, and there is very little deposition of subcutaneous fat. The infant can move its limbs slightly, cries feebly, and often dies in a few hours or days. Yet it is this class of prematurely born infants whose lives I expect to see preserved in the future, when all the precautions which I am about to describe against external and dangerous influences have been taken and improved apparatus has been employed.

**THIRTY-TWO WEEKS.**—Again, using Hecker's and Lusk's figures for the thirty-second, thirty-sixth, and thirty-eighth weeks, at about the thirty-second week of intra-uterine life the foetus measures from 39 to 41 cm. (about  $15\frac{1}{2}$  to  $16\frac{1}{2}$  inches) and weighs about 1560 grammes (52 ounces). The hair of the head by this time has increased in thickness, and the lanugo, which in many cases is pronounced from the twenty-eighth to the thirty-second week, has either begun to disappear or has entirely disappeared from the face. The nails, which between the twenty-eighth and thirty-second weeks are often not well developed, now present a normal appearance, though they frequently do not quite reach the tips of the fingers. At this age, also, in boys, it is often possible to feel the testicle in the scrotum. There is usually, also, at this age, in a healthy foetus, considerable deposition of subcutaneous fat, and the senile aspect of the earlier periods of intra-uterine life is much lessened.

**THIRTY-SIX WEEKS.**—At about the thirty-sixth week the length of the foetus is from 42 to 44 cm. (about  $16\frac{3}{4}$  to  $17\frac{1}{2}$  inches) and its weight is about 1920 grammes (64 ounces). The lanugo has usually at this period disappeared, and the infant, although less energetic than at full term, is decidedly stronger than in the previous periods which I have mentioned. It sleeps a great deal, and is still in a condition to die easily unless carefully looked after.

**THIRTY-EIGHT WEEKS.**—At about the thirty-eighth week of intra-uterine life the infant measures about 45 to 47 cm. (about  $17\frac{3}{4}$  to  $18\frac{3}{4}$  inches) and weighs about 2310 grammes (77 ounces).

**WEIGHT.**—It is important to remember that the weight of premature infants of the same age varies at birth, just as we have seen that it does in the case of infants born at term.

In treating these cases, observance of their weight is of the greatest importance, and until we have obtained a regular progressive daily increase in their weight we are never sure that they are thriving sufficiently to live. The daily gain which the premature infant should make has not yet been determined, but it is much less than is expected when an infant is born at

full term, and may be stated to be about 10 to 20 grammes ( $\frac{1}{3}$  to  $\frac{2}{3}$  ounce). Any decided loss in weight, such as 30 to 40 grammes (1 to  $1\frac{1}{3}$  ounces), beyond what would occur from natural causes, should make us look upon the infant as being in a critical condition and impress upon us the importance of taking active measures to prevent further loss. This loss in weight must, as it is relatively so small, be carefully adjusted to the loss which naturally occurs from the faecal discharges. Thus, the total amount of loss in weight from the faecal discharges may amount in these premature infants to from 30 to 60 grammes (1 to 2 ounces) for each faecal discharge, and this may entail a considerable loss of the infant's weight in the twenty-four hours beyond that occasioned by defective nutrition.

I have here to show you an infant (Case 102) prematurely born at about the twenty-eighth week of intra-uterine life.

CASE 102.



Infant premature at seventh month. Birth-weight, 1740 grammes ; present weight, 1540 grammes ; present age, 10 days.

Its weight at birth was 1740 grammes (about  $3\frac{5}{8}$  pounds). It is now ten days old and has lost about 240 grammes (about  $\frac{1}{2}$  pound). You see that it is in a very somnolent condition, that it has very little hair on its head, and very little subcutaneous fat. You will also notice the senile expression of its face, that there is no appearance of lanugo, and that the nails are well formed. The small size of the infant will be still more appreciated if you compare it with the hand of the nurse, which, for comparison, is placed beside it.

There have been so few observations recorded of the development of the various parts of the foetus in the later months of intra-uterine life that I am not prepared to describe systematically the development of the premature infant as I have already done that of the infant at term (Lecture III., page 54). There are, however, some facts which I have observed and others which have been recorded.

**HEAD, THORAX, AND ABDOMEN.**—Looking at this infant (Case 102) critically, we notice that all those anatomical conditions which I have emphasized in my description of the infant at term as being especially prominent are still more marked in the premature infant. Thus, you will notice how large the head is in comparison with the thorax, and how very large, in proportion, is the abdomen. The abdomen is in almost every case much distended in premature infants, owing to the large proportionate size of the liver. This distention of the abdomen lasts for many weeks, and



even months, and its gradual return to the normal size and appearance is one of the signs that the infant is doing well and is gradually acquiring the normal anatomical development of the infant born at term.

FIG. 71.

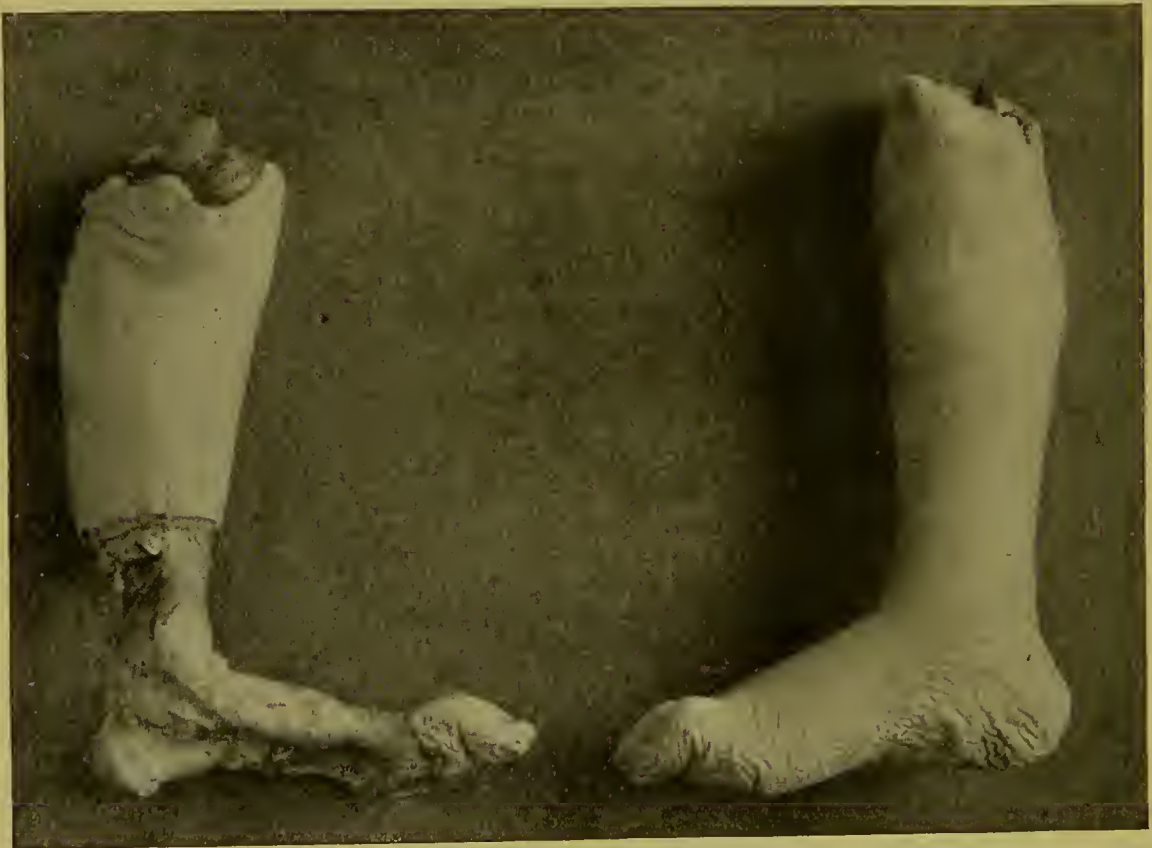


Tracings of fetal feet (natural size), seven months old.

**SKIN.**—The various changes in the color of the skin, which I have already described as represented by erythema neonatorum and icterus neonatorum, I have noticed to occur in the premature infant as they do in the infant at term.

**SWEAT-GLANDS.**—I have told you that the function of the sweat-glands is, as a rule, not developed at birth, and that we do not expect the infant in the early weeks of life to perspire. I have also told you that there is a great variation as to the time of the development of the function of the sweat-glands. In an

FIG. 72.



Legs and feet (natural size) of infant premature at seven months. Left foot dissected and showing internal arch. Partially dissected metatarso-phalangeal joint of great toe in shadow. Inferior edge of scaphoid shows as a shaded line.

infant premature at seven and one-half months I have noticed free perspiration take place after it had been born one week.



**FEET.**—I have already told you how few observations have been made on the development of the various parts of the foetus in the later months of intra-uterine life, and I think all facts determined at this period of existence should be recorded. I therefore consider Dane's observations on the instep of a seven months' foetus (Case 103) born alive to be of value in connection with what I have already said about the feet of infants born at term (Lecture II., p. 50). These tracings (Fig. 71) represent this premature infant's feet, and you see how admirably the presence of the instep is shown.

The infant died a few hours after birth, and I have here to show you (Fig. 72) its feet and lower legs. The skin of the right leg is badly wrinkled by the alcohol in which it was preserved. It looks strikingly like the foot as it appears in adults, and its arch stands out plainly, unmasked by any pads of fat. The left foot has been dissected down to the ligaments. The arch made by the os calcis, cuboid, and fifth metatarsal bones represents the lower edge of the cut. On the inner border of the foot the metatarso-phalangeal joint of the great toe is seen partially dissected. Behind this the enlargement at the tarso-metatarsal joint forms a considerable bulging. Behind and above the latter the inferior edge of the scaphoid shows as a shaded line.

From these specimens and from the tracings we see that the foot at seven months closely approaches in external appearances the well-developed foot of the adult, and that when the infant was supported with its feet on smoked paper it left an excellent impression. The dissection also shows a remarkably well constructed bony framework.

**GASTRIC CAPACITY.**—As the question of the proper amount of food to be given to a premature infant is of the utmost importance, it is well to know about what the average gastric capacity of the foetus is during the later months of intra-uterine life. No series of complete and reliable observations on this point have been made, that I know of, and the rules by which we are guided must for the present be very general ones. The less the weight of the infant, the less, in many cases, is the gastric capacity. I have here to show you some foetal stomachs.

The first stomach (Fig. 73) is that of a foetus about four and one-half months old, and is interesting merely as showing the relatively advanced development of the lesser and

FIG. 74.

FIG. 73.



Foetal stomach (natural size), four and one-half months old.



Foetal stomach (natural size), seven and one-half months old. Weight of foetus, 1920 grammes. Gastric capacity, 18 c.c.

greater curvatures at this age, as well as the rapid growth which takes place between the fourth and the seventh month.

The next stomach (Fig. 74, p. 293) was taken from an infant born prematurely at about the twenty-ninth to the thirtieth week. It is of a rather peculiar shape, corresponding to that which I have described to you in a previous lecture (Lecture IV., Fig. 29, p. 89). The weight of this fœtus was 1920 grammes (about 4 pounds). Its gastric capacity was 18 c.c. (about  $4\frac{1}{2}$  drachms).

This next stomach (Fig. 75) was taken from a fœtus at about the thirty-second week, which died in forty-five minutes from the time of its birth. The gastric capacity was 22 c.c. ( $5\frac{1}{2}$  drachms). The weight of this infant was 1230 grammes (2 pounds 9 ounces).

FIG. 75.



Fœtal stomach (natural size), eight months old. Weight of fœtus, 1230 grammes. Gastric capacity, 22 c.c.

The next stomach (Fig. 76) was taken from a fœtus born at about the thirty-second week of intra-uterine life, and weighing 1440 grammes (about 3 pounds). Its gastric capacity was 8 c.c. (about 2 drachms).

FIG. 76.



Fœtal stomach (natural size), eight months old. Weight of fœtus, 1440 grammes. Gastric capacity, 8 c.c.

**INTESTINAL CONTENTS.**—The meconium in premature infants presents the same appearance as is seen in infants at term. When the food is properly regulated, the fœcal discharges assume the consistency and color which are seen in those of infants who have been born at term. This color in its usual varieties is well represented in this plate (Plate III., 6, 7, 8, 9, facing p. 112).

**AMYLOLYTIC FUNCTION.**—The amylolytic function of the infant at term is so slightly developed that we may safely assume that it should not be depended upon for the digestion of starch in the premature infant under any circumstances.



**SUGAR.**—Although we must assume that the function of absorbing sugar is not developed to the same extent in the premature infant as in the infant at term, yet, in all probability, it is more highly developed than the other functions of digestion. Sugar is needed to keep up the animal heat of the premature infant, which is so very much more readily lessened than in the infant at term. Sugar, therefore, is an important element in the premature infant's food, but should be given at first in a much lower percentage than later, when the equilibrium of the gastro-enteric tract has been acquired.

**FAT AND PROTEID DIGESTION.**—The function of digesting fat and proteids is in a much more undeveloped condition in the premature infant than in the infant born at term, and should, therefore, not be depended upon to the same degree as can safely be done in arranging the food for the older infant. Much smaller percentages of these elements should be given to the premature infant than to the infant at term, both for purposes of digestion and of absorption, for, in all probability, the power of absorption of the gastro-enteric tract in premature infants is in a very undeveloped condition.

**KIDNEY.**—We should expect, from the lack of development of the kidney in premature infants, to find a considerable deposit of uric acid, such as I have described as appearing in the early days of life in infants at term (Lecture IV., page 111, Plate III., 1). This is, in fact, the case, and the appearance of uric acid on the napkins of premature infants is, therefore, not necessarily to be looked upon as denoting an abnormal condition. It should, however, be carefully watched, for where it becomes excessive it is an indication that the infant's food has not been properly adjusted to its digestive powers and that the infant may soon begin to fail.

**CIRCULATION.**—The heart in premature infants has not yet arrived at the complete stage of development needed to render it a reliable central force which can fulfil the demands that will be made on it in the external world to sustain the equilibrium of the circulation. Therefore as little work as is possible should be thrown upon the heart, and the infant should be kept quiet, and not be carried about, as is customary with infants born at term.

In a number of cases which I have carefully examined I have failed to detect a cardiac murmur, which leads me to think that the foramen ovale closes soon after birth in the same manner as it does in the infant at term.

**ANIMAL HEAT.**—The animal heat of the premature infant is much more easily reduced, and is even more important to its vitality, than it is in the infant at term. Following the rule that the smaller the size of the human being the greater proportionately is the entire surface, and, therefore, the greater the opportunity for lowering its temperature, an atmosphere which is suitable for the infant at term is too cold for the premature infant.



Premature infants should be thoroughly protected from changes of temperature of the atmosphere in which they live, and this temperature should be raised to a point which will correspond in some degree to that of intra-uterine life.

**AIR.**—Just as a necessity exists for the premature infant to live for some weeks in an atmosphere where the air approaches in its temperature the warmth which exists in intra-uterine life, so is it almost to the same degree important that the air which it breathes should be free from dust and micro-organisms. The lung is in a very undeveloped condition, and although it may be sufficiently developed to carry on the function required of it in extra-uterine life, yet all its tissues are exceedingly sensitive, as are those of the nose and naso-pharynx through which the air must be introduced to the lungs. The air of the ordinary room where infants live when they are born necessarily contains many impurities, both irritating and morbid. This irritation of the respiratory passages may of itself be sufficient to reduce the vitality of the infant beyond the limits of life.

**TOUCH.**—Premature infants have to be carefully handled, as they die easily from influences which would have little or no effect upon the infant born at term. In intra-uterine life they are floating in a fluid which practically prevents what in the external world corresponds to *handling*. While they are living in the amniotic fluid they are almost completely protected from the influence of touch, which necessarily affects them as soon as they are born. *Touch*, then, is an important element, to be as much as possible avoided when the premature infant is born, as it has a decided tendency to lower the vitality.

An instance of the care which is needed to preserve the lives of these infants came to my notice in the case of an infant (Case 104) premature at eight months which was in my service at the City Hospital.

During the first week or ten days of its life this infant was in charge of an unusually careful and experienced nurse, who appreciated the risk of handling it. It was gaining in weight and was doing well; but unfortunately another nurse was substituted who did not understand this class of infants so well. She allowed the patients in the ward to handle the infant, to talk to it, and to surround it with various similar deleterious influences. For a few days it lost in weight, and then it suddenly died. There is no doubt that it was unable to withstand the amount of handling which would have done no harm to an older infant.

**LIGHT.**—The premature infant should live in comparative darkness during the early weeks of its life. Light is not requisite for the development of the infant in the earlier stages of its existence, and too much light will impair its vitality. It is important to adapt the light to the stage of its development, and gradually to accustom it to more light as it grows older.

**SOUND.**—In the normal intra-uterine conditions the infant is very slightly exposed to sound, and all its functions are adapted to silence rather than to the many noises which unavoidably surround it in the external

world. We should therefore arrange that from the minute it is born it is protected from noise.

**PULSE, TEMPERATURE, AND RESPIRATION.**—I have not any very exact records of the average pulse, temperature, and respiration found in premature infants. These infants seem to present rather irregular types of temperature and pulse, as well as of respiration. They have to be so carefully handled that observations as to these physical signs must be made with great caution. The main point in regard to these three conditions of the premature infant is that they are all represented by irregularity. The *temperature* of the premature infant, when it has once begun to gain in weight and to thrive, is usually a little above the normal temperature of the infant at term. Before it has begun to gain in weight and when its vitality is much depressed, the temperature, as would naturally be expected, is rather below the normal standard; and we should watch this sign with the greatest solicitude, as a decided and continuous depression is often indicative of death.

The *pulse* is difficult to take in the premature infant, and, as a rule, is somewhat quicker than in the infant at term.

The *respirations*, irregular in the infant at term, are still more irregular in the premature infant, at times being rapid for a few seconds, and then becoming almost imperceptible for some minutes.

This infant which I have had brought here to show you (Case 105) was prematurely born at the thirty-second week, and illustrates the fact that a premature infant, if its weight is not extremely small and if its development is somewhat above the average expected for its age, can live and thrive without all the precautions being taken for its preservation which I have already spoken of. These cases, however, merely emphasize the fact that if we are guided by them in our treatment of premature infants in general, we shall make many fatal mistakes and far fewer lives will be saved.

This infant weighed at birth 2954 grammes (about  $6\frac{1}{2}$  pounds). This would indicate that its chances for living were good, the other conditions of its development being normal, as you will understand by referring to this table (Table 2, p. 49) of the relation of weight to vitality. You see that the weight of this infant is between 2500 and 3000 grammes, showing that the vitality has risen above what is designated as low; in fact, it is within 49 grammes (about  $1\frac{3}{4}$  ounces) of the 3000 grammes which represent a fair vitality. The infant was kept in a room where the temperature was  $23.8^{\circ}$  C. ( $75^{\circ}$  F.). The air which was around its bed, which was in a basket, was heated to about  $29.4^{\circ}$  C. ( $85^{\circ}$  F.). The infant was wrapped in fresh absorbent cotton. During the first twenty-four hours one teaspoonful of food was given every hour. After that time it was fed every hour during the day, and every two hours during the night. On the third day the mother had a sufficient supply of breast-milk, which flowed easily. The infant was therefore fed with the breast-milk from a spoon for a week, was then put directly to the breast, and continued to nurse until the end of the third week, when, as its mother's milk failed, it again had to be placed upon a carefully regulated substitute food.

There is nothing else especially interesting to record either in its history or in its physical condition, except that it had a small umbilical hernia, which did not cause any discomfort, and which closed at the end of the third month.

With this attention to its warmth and food it thrived as any infant at term would have done, and has since been well and strong.

Here is a table (Table 81) which represents its weight for sixty-one days, and here is the record (Chart 5) of its temperature and pulse during the first three weeks of its life.

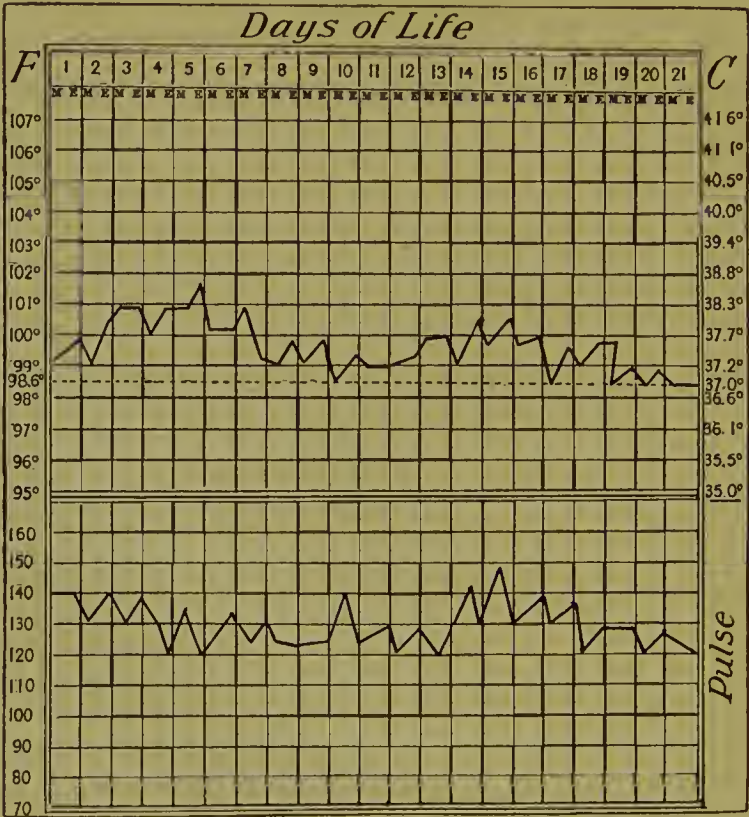


TABLE 81.

*Weight for Sixty-One Days of Infant Premature at Thirty-Two Weeks.*

Day of Life.	Grammes. (Pounds, Oz.)		Remarks.
Birth-weight . . .	2964	( 6 8)	Cow's milk, with spoon.
Third . . . . .	2724	( 6 0)	Mother's milk, with spoon.
Sixth . . . . .	2814	( 6 3)	" " " "
Ninth . . . . .	2964	( 6 8)	Mother's milk direct from breast.
Thirteenth . . . .	3178	( 7 0)	" " " " "
Sixteenth . . . .	3388	( 7 7)	" " " " "
Twentieth . . . .	3598	( 7 14)	Modified milk.
Twenty-third . . .	3812	( 8 6)	" "
Twenty-seventh . .	4116	( 9 1)	" "
Thirtieth . . . .	4236	( 9 5)	" "
Thirty-third . . .	4476	( 9 13)	" "
Thirty-seventh . .	4600	(10 2)	" "
Forty-first . . . .	4840	(10 10)	" "
Forty-fourth . . .	4900	(10 12)	" "
Forty-eighth . . .	4994	(11 0)	" "
Fifty-first . . . .	5084	(11 3)	" "
Fifty-fifth . . . .	5234	(11 8)	" "
Fifty-eighth . . .	5324	(11 11)	" "
Sixty-first . . . .	5384	(11 13)	" "

CHART V.



All the possible causes which may reduce the premature infant's vitality must be thoroughly understood and obviated. You must also appreciate that a failure to recognize and obviate one of these causes may defeat the benefit which may arise from attending to all the others.

The premature infant should, so far as is possible, be restored to the



condition that it has been forced out of,—namely, a condition of darkness, silence, and warmth.

You see, therefore, that there are a great many points to be considered when you undertake to treat intelligently an infant prematurely born, and it is this treatment which I shall endeavor to explain to you.

**AMOUNT OF FOOD AT EACH FEEDING.**—I have already stated that the amount of food to be given at each feeding is very important. By referring to the weights and gastric capacities of the premature infants already described (Figs. 74, 75, 76, page 294), you will see how misleading is the weight of the infant if we take it as an exact index of the gastric capacity. We must, however, take the weight into account, as, from even the very imperfect data at our command, the weight of premature infants appears to bear a decided relation to their gastric capacity. We should at least be more inclined to increase rapidly the initial amount of food given in the case of an infant of large weight than in that of a small one. It is better to begin with too small rather than too large a quantity. By watching carefully for signs of hunger, a desire which the infant expresses by feeble but continuous cries, which stop when the food is given to it, we can gradually increase the amount until it seems to want it at regular intervals, is satisfied, and sleeps quietly during the intervals of feeding.

By referring to these foetal stomachs (Figs. 73, 74, 75, 76, pages 293, 294), you will understand that it is safer to begin with 4 or 5 c.c. (about 1 drachm) and gradually to increase the amount up to a point where our very imperfect knowledge on this subject, derived partly from the weight of the infant, makes us believe that the stomach is full, than to begin at once with the larger amount. It is absolutely necessary that we should avoid undue distention of the stomach, as this may prove fatal.

**INTERVALS OF FEEDING.**—The premature infant's stomach is small, and is, in all probability, emptied quickly, and, as food is necessary for keeping up the animal heat required for the maintenance of its life, the intervals of feeding should be much shorter than those required for the infant at term. In the early days, and in fact weeks, of life, I have found that it is better to feed the premature infant regularly every hour. Four or five weeks after birth, if it is gaining in weight and is digesting well, these intervals can be so lengthened that by the time it arrives at term we can usually make the feeding intervals one and a quarter to one and a half hours, and a few weeks later two hours.

**COMPOSITION OF FOOD.**—The careful adjustment of the premature infant's food to its digestive organs is of even greater importance than in the case of the infant at term. There is no doubt that if we consider the hypersensitive condition and the undeveloped state of the digestive organs prior to birth, the most exact adjustment of the food to these digestive organs is absolutely necessary. This adjustment is best accomplished by means of carefully prepared prescriptions at the Milk-Laboratory. Through this instrument of precision three important advantages are gained :

(1) we insure a clean food free from micro-organisms ; (2) we can obtain low and properly balanced percentages of the constituents of the milk ; (3) we have, at any time, the power of exactly varying, to within a fraction of one-half of one per cent., the percentages of the three most important elements of the milk,—namely, the fat, the sugar, and the proteids. In addition to these latter two advantages possessed by the substitute over the maternal method of feeding are others of almost equal importance. One advantage is the absence of variation in the substitute food arising from emotional causes, and another is that the infant need not be taken from the incubator to be fed.

This prescription (Prescription 30) is the one which I should begin with in feeding an infant premature from the twenty-eighth to the thirty-sixth week :

PREScription 30.

R Fat . . . . .	1.00
Sugar . . . . .	3.00
Proteids . . . . .	0.50
24 meals, each 4 c.c. (1 drachm).	
Heat to 75° C. (167° F.).	
Reaction faintly alkaline.	

If the infant is over twenty-nine weeks, or if it is unusually large for its age, and especially if it is unsatisfied, it is well in a few days to change the prescription to this one (Prescription 31):

PREScription 31.

R Fat . . . . .	1.50
Sugar . . . . .	4.00
Proteids . . . . .	0.50
24 meals, each 8 c.c. (2 drachms).	

If the infant is over thirty-two weeks, vary the prescription in a few days, under the same conditions as in Prescription 31, to—

PREScription 32.

R Fat . . . . .	1.50
Sugar . . . . .	5.00
Proteids . . . . .	0.75
24 meals, each 12 c.c. (3 drachms).	

If the infant is over thirty-six weeks, the milk should, after forty-eight hours, be increased and strengthened to—

PREScription 33.

R Fat . . . . .	2.00
Sugar . . . . .	5.50
Proteids . . . . .	1.00
24 meals, each 16 c.c. (4 drachms).	



The infant, however, under all circumstances, must be watched critically, and any or all of the percentages of the elements or amounts of the food increased or decreased according to the individual indications.

When the infant is born at the thirty-eighth or thirty-ninth week its development is usually so near that of the infant at term that the incubator will not be needed, and the food can be given in about the proportions which would be adapted to the early days of the infant at term (Prescription 3, page 181).

**WEIGHING.**—A knowledge of the weight of the infant is exceedingly important in the management of its feeding, and changes in the degree of its vitality take place so rapidly that the daily increase or decrease in its weight becomes the principal index by which we are guided in changing the food.

The handling, however, which is necessary to obtain the daily weight is often a serious obstacle to the maintenance of its vitality. We should, therefore, endeavor to obtain the weight without reducing the vitality. The means for doing this I shall describe later.

**CLEANSING AND CLOTHING.**—A premature infant should not be bathed beyond what is necessary for simple cleanliness.

It should not be dressed, but should be wrapped in absorbent cotton. The cotton soon cleanses it thoroughly, and, if changed twice daily, or oftener if necessary, supplies the place of both clothes and bath. As a rule, no oil or ointment should be applied to its skin.

**INCUBATORS.**—I have already told you, when speaking of milk-laboratories, that it is better not to spare expense in obtaining the very best means for preserving life which comes within our power. If you appreciate this great principle, which lies at the root of all successful methods of preserving the lives of premature infants, you will understand that even the smallest details which I have spoken of, and which I shall again mention more at length, are not to be considered trivial or beneath your earnest and careful attention. The premature infant's life is so difficult to preserve that we should make use of every device which our ingenuity can suggest. From the very moment it enters the world its viability is likely to be brought to an end, and every minute is of importance in our endeavors to combat this tendency. We should, therefore, be ready to protect it at once from the adverse influences which surround it. We should have decided views of how to treat this early period of life, and also have the means which we think should be best employed ready to be supplied at once.

In the treatment of premature infants only one of the principal methods of maintaining their viability usually receives much attention. It is commonly supposed that if the atmosphere which surrounds the infant is kept at a sufficiently high temperature all that is requisite has been done for its safety. This until very recently has been accomplished by placing the infant in a room where the temperature is as high as the nurse in charge



of it is able to endure. This procedure is necessarily a very uncomfortable one for the nurse, and at times renders it almost impossible for her to use her mind intelligently. It also requires a much more frequent change of nurses than would be the case if the atmosphere of the nursery were cooler. In addition to this means of preventing undue loss of heat, the infant is wrapped in cotton-wool and placed in a basket lined with hot-water bottles, or it is placed at once in an apparatus which is called an incubator. These incubators have been used for many years in different parts of the world, notably in Paris. They are of different forms, which I need not describe here, as there is nothing especially important to recommend about them when we compare them with the latest form of incubator, which I shall presently describe to you (Fig. 80, page 306). The purpose of them all is the same,—namely, to keep the infant warm. Some of them are made of tin, with double walls, so that hot water can be continually kept in them, and thus sufficient warmth be applied to the infant. Others are made of wood, and kept warm by means of hot-water bottles introduced into them from below. None of them combines in the best way the many requisites necessary to preserve the premature infant's life.

The name incubator has been applied to these various devices for keeping up the animal heat of the infant. It is a misnomer, for incubation means hatching, and, in the precise sense of the word, the premature infant is already hatched and has been incubated. What we accomplish by this apparatus is analogous to what is done to keep up the animal heat and preserve the lives of young chickens after they are hatched, and the name *brooder* would be more applicable to machines devised for preserving the lives of premature infants than the term *incubator*. The word incubator is, however, so generally used to represent an apparatus intended to preserve the premature infant's life until it has attained the age of two hundred and eighty days, that it will, in all probability, for the present be retained. The true meaning, however, of what I am endeavoring to explain to you is so much better expressed by the word *brooder*, meaning warming, and not hatching, that I shall use it in speaking of the latest apparatus which has been invented for the purpose of human brooding.

Before speaking of the treatment of premature infants where every detail can be carried out in the most approved manner, I shall mention a few cases which illustrate the different points to which I have just referred. For instance, where it is impossible to obtain an incubator at once for preserving the premature infant's animal heat, it must be treated in the way which I have already referred to, by placing it in a room where the temperature has been raised to 32.2° C. (90° F.).

I have here a picture (Case 106, Fig. 77, page 303) representing an infant premature at the seventh month, and now fourteen weeks old.

It is in this basket, enveloped in cotton-wool, and covered with blankets. You see that the thermometer is kept in the basket beside it, and the nurse has continually to watch it.

It was under the care of Dr. Hunt, of West Newton, with whom I saw it in consultation. It was placed in the incubator when it was four weeks old. It was taken out of the incubator when it was twelve weeks old. At this time it had gained very little in

FIG. 77.



Infant premature at twenty-eighth week. Birth-weight, 1200 grammes. Present age, fourteen weeks. Treated in basket heated by hot-water bottles. Temperature of air in basket shown by thermometer introduced between side of the basket and the blanket. The infant was removed from the incubator when it was twelve weeks old.

weight, was emaciated, puny, and feeble. Its abdomen was much distended, and its skin wrinkled, dry, and yellowish in color.

Here is a picture (Fig. 78) of this infant taken when it was fourteen weeks old, which shows the senile expression of the face so characteristic of premature infants at birth, and later when they are not thriving.

FIG. 78.



Infant premature at twenty-eight weeks. Present age, fourteen weeks.

Here is another picture (Fig. 79) of this infant, with its day nurse and its night nurse, its basket, and the scales on which it was weighed daily.



This picture is instructive in making you appreciate how small this infant was, as is well shown by comparing the size of its head with that of the nurses' heads.

FIG. 79.



Infant premature at twenty-eight weeks. Present age, fourteen weeks.

The next infant (Case 107) which I shall speak of was one which was prematurely born at about the thirty-third week. It was treated in a basket warmed with heaters, and in a room where the temperature was kept from 29.44° C. (85° F.) to 32.22° C. (90° F.). It was carefully nursed by a night nurse and a day nurse.

It weighed 2490 grammes (about 5 pounds 3 ounces). It was under the care of Dr. Edward Reynolds, with whom I saw it in consultation. Its food was carefully regulated at the Milk-Laboratory, and the first prescription which was written for it, and which proved to be adapted to its digestion during the first week or ten days, was this one (Prescription 34):

#### PRESCRIPTION 34.

R Fat . . . . .	1.00
Sugar . . . . .	3.00
Proteids . . . . .	1.00
Lime water . . . . .	5.00

The mixture to be heated for twenty minutes at 68.38° C. (155° F.).

From my later experience with these cases, I should begin with the percentage of proteids 0.50, as I have already described in this prescription (Prescription 30, p. 300). In the early days of this infant's life oxygen had to be administered to it for two or three minutes every hour. It was fed every hour, and received six drops of brandy with each feeding. At my first examination, which was made when it was six hours old, a distinct cardiac murmur was heard at the base of the sternum, and there were a few fine moist râles throughout both lungs. The murmur and the râles disappeared in the course of a week, and the infant, after losing 135 grammes (about 4½ ounces) in the first three days, began to make small gains in weight, and when it was seven weeks old it weighed 2730 grammes (about 5 pounds 11 ounces), was plump, had a healthy color, and seemed very well. It began to perspire when it was seven weeks old.

This case received the very closest attention, and was treated with all the details for safety which were possible to be attained without the use of an incubator, but we must consider that its weight, 2490 grammes (about 5 pounds 3 ounces), and its age, thirty-



three weeks, were such as to make the preservation of its life a much more simple matter than that of the infant (Case 106) whose picture I have just shown you, and whose light weight pointed towards so undeveloped and premature a condition that any omission in regard to the closest detail of treatment would have been likely to prove fatal.

This infant had progressed so far in its general condition and development that at the age of eight weeks it was taken out of the cotton in which up to that time it had been wrapped and was dressed. At this time it was taking 56 c.c. ( $1\frac{3}{4}$  ounces) at each meal, and was fed once in two hours.

The next case (Case 108) is that of an infant which was four weeks premature, and which was, for a premature infant, tolerably vigorous at birth. It was under the care of Dr. Samuel Breck, with whom I saw it in consultation. It was not placed in an incubator. Unfortunately, its nurse had no idea of the importance of protecting it from external influences. It was fed on a carefully prepared food from the Milk-Laboratory, and began to gain in weight, and in every way showed no evidence of its vitality being interfered with; but the nurse was possessed with the idea that it needed plenty of cold fresh air. The window in the infant's room was left open one night when the weather was quite cool. The following day it did not take its food well, was somewhat cyanotic, and was found to have lost almost 240 grammes ( $\frac{1}{2}$  pound). It was then placed, as it should have been in the beginning, in a warm room, treated with the utmost care, and not handled much. None of these measures, however, were sufficient to prevent a still further lessening of its vitality. It never rallied from the first blow which was struck at its vitality, and lost its life practically through the ignorance of the nurse who was in charge of it.

A post-mortem examination showed nothing abnormal, except that the mesenteric glands were somewhat enlarged.

The next case (Case 109) was that of an infant born at about the twenty-fifth week of intra-uterine life. Its weight was 1080 grammes (about  $2\frac{1}{4}$  pounds). There are a number of interesting points to be recorded in this case.

It was not strong enough to suck, and had to be fed with a spoon. Its mother's milk, the analysis (Analysis 55) of which I have here to show you, at once caused such disturbance that modified milk from the Laboratory had to be substituted.

#### ANALYSIS 55.

Fat . . . . .	1.29
Sugar . . . . .	4.10
Proteids . . . . .	6.83
Ash . . . . .	0.26
Total solids . . . . .	12.28
Water . . . . .	87.72
	<hr/> 100.00

This is the prescription for the modified milk which it digested well:

#### PRESCRIPTION 35.

##### *Modified Milk.*

R Fat . . . . .	1.00
Sugar . . . . .	3.00
Proteids . . . . .	0.75

The infant's temperature in the rectum was  $36.7^{\circ}$  C. ( $98^{\circ}$  F.). It seemed to be doing fairly well, but did not gain in weight, and on the fifth day of its life was unable to swallow. It was then fed by gavage.

It was treated with great care so far as keeping it warm was concerned, but an incubator could not be obtained for it, and it died when it was seven days old.

It is interesting in this case to notice that the meconium came as is usual in the infant at term, and began to change its color on the third day, and that by the fifth day the faecal movements were yellow and well digested.

These particulars were given to me by Dr. Woods, who was in charge of the case. Its death was evidently due to the lowering of its vitality consequent upon its age and lack of sufficient development to withstand the influences surrounding it in extra-uterine life.

I now wish you to examine this incubator (Fig. 80), which was devised by Dr. Worcester, of Waltham, Massachusetts. It is far superior in its mechanism and in its general utility to the other incubators which I have already referred to, except that of Tarnier, which it closely resembles. It is practically a wooden box, 76 cm. ( $2\frac{1}{2}$  feet) long, 45.5 cm. ( $1\frac{1}{2}$  feet) wide, and 76 cm. ( $2\frac{1}{2}$  feet) high. This box, as you see, has a glass lid, which can be raised when necessary, but which is intended to be kept closed and to be used as a window through which to observe the infant. Two or

FIG. 80.



To left of incubator is the oxygen tank. To left of incubator on the floor is the lamp. At upper right end of incubator is an anemometer.

three holes at the end and at the bottom of the box allow the entrance of air. A hole at the top and end of the box, fitted with an anemometer, serves as an exit for the air. The continuous motion of the anemometer shows that the ventilation is being carried on properly. At the bottom of the box is a metallic boiler. A pipe from this boiler is brought through the end of the box, turns upward for a few inches, and then turns back and enters the box, where it connects again with the boiler. Outside of the end





DAYS OF LIFE.	INTERVALS BETWEEN MEALS.	AMOUNT AT EACH MEAL.		PERCENTAGES OF FOOD.				FÆCAL DISCHARGES.			WEIGHT.		
				Fat.	Sugar.	Proteids.	Lime Water.	No.	Character.	W'ght.			
		C.c.	Dr'ms.							Oz.	Gr'ms.	Lbs.	Oz.
1	.....	.....	.....	...	3 per ct. sol. in aq. dis.	.....	.....	..	meconium.	.....	2040	4	4
2	1 hour.	4	1	1.00	3.00	1.00	5.00	2	brown, small.	.....	2040	4	4
3	1 hour.	4	1	1.00	3.00	1.00	5.00	2	"	.....	2040	4	4
4	1 hour.	4	1	1.00	3.00	1.00	5.00	2	"	.....	2040	4	4
5	1 hour.	4	1	1.00	3.00	1.00	5.00	2	only fairly digested.	.....	2010	4	3
6	1 hour.	4	1	1.00	3.00	1.00	5.00	2	"	.....	2040	4	4
7	1 hour.	4	1	1.00	3.00	1.00	5.00	2	"	.....	2040	4	4
8	1 hour.	4	1	1.00	3.00	1.00	5.00	2	"	.....	2055	4	4½
9	1 hour.	4	1	1.00	4.00	1.00	5.00	2	yellow.	.....	2010	4	3
10	1 hour.	4	1	1.00	4.00	1.00	5.00	2	well digested.	.....	2025	4	3½
11	1 hour.	8	2	1.00	4.00	1.00	5.00	2	"	.....	2025	4	3½
12	1 hour.	8	2	1.00	4.00	1.00	5.00	2	"	.....	2055	4	4½
13	1 hour.	8	2	1.00	4.00	1.00	5.00	2	"	.....	2070	4	5
14	1 hour.	8-10	2-2½	1.00	4.00	1.00	5.00	2	"	.....	2070	4	5
15	1 hour.	8-10	2-2½	1.00	4.00	1.00	5.00	2	"	.....	2070	4	5
16	1 hour.	12	3	1.50	5.00	1.00	5.00	2	"	.....	2160	4	8
17	1 hour.	12	3	1.50	5.00	1.00	5.00	2	"	.....	2160	4	8
18	1 hour.	12	3	1.50	5.00	1.00	5.00	2	"	.....	2100	4	6
19	1 hour.	12	3	1.50	5.00	1.00	5.00	2	"	.....	2130	4	7
20	1 hour.	12-14	3-3½	1.50	5.00	1.00	5.00	2	"	.....	2160	4	8
21	1 hour.	16	4	1.50	5.00	1.00	5.00	2	"	.....	2175	4	8½
22	1 hour.	16	4	1.50	5.00	1.00	5.00	2	"	.....	2220	4	10
23	1 hour.	16-18	4-4½	1.50	5.00	1.00	5.00	2	"	.....	2235	4	10½
24	1 hour.	16-18	4-4½	1.50	5.00	1.00	5.00	2	"	.....	2250	4	11
25	1 hour.	18-20	4½-5	2.00	5.00	1.00	5.00	1	"	.....	2280	4	12
26	1 hour.	18-20	4½-5	2.00	5.00	1.00	5.00	2	"	.....	2280	4	12
27	1 hour.	18-20	4½-5	2.00	5.00	1.00	5.00	1	"	.....	2295	4	12½
28	1 hour.	18-20	4½-5	2.00	5.00	1.00	5.00	2	"	.....	2310	4	13
29	1 hour.	20	5	2.00	5.00	1.00	5.00	2	"	.....	2310	4	13
30	1 hour.	22	5½	2.00	5.00	1.00	5.00	3	slightly green.	.....	2280	4	12
31	1 hour.	22	5½	2.00	5.00	1.00	5.00	4	"	.....	2287	4	12½
32	1 hour.	22	5½	2.00	5.00	1.00	5.00	4	"	.....	2295	4	12½
33	1 hour.	24-26	6-6½	2.00	5.00	1.00	5.00	5	"	.....	2295	4	12½
34	1 hour.	28	7	2.00	6.00	1.00	10.00	8	"	.....	2295	4	12½
35	1¼ hrs.	32	8	2.00	6.00	1.00	10.00	5	yellow and well digested.	.....	2340	4	14
36	1¼ hrs.	32	8	2.00	6.00	1.00	5.00	5	"	.....	2400	5	0
37	1¼ hrs.	32	8	2.00	6.00	1.00	5.00	3	"	.....	2160	5	2
38	1¼ hrs.	48	12	2.00	6.00	1.00	5.00	3	"	.....	2190	5	3
39	1¼ hrs.	48	12	2.00	6.00	1.00	5.00	3	"	.....	2520	5	4
40	1¼ hrs.	48	12	2.00	6.00	1.00	5.00	5	"	3	2550	5	5
41	1¼ hrs.	48	12	2.00	6.00	1.00	5.00	2	"	2½	2550	5	5
42	1½ hrs.	48	12	2.00	6.00	1.00	5.00	2	"	2½	2550	5	5
43	1½ hrs.	48	12	2.00	6.00	1.00	5.00	1	"	2½	2640	5	8
44	1½ hrs.	48	12	2.00	6.00	1.00	5.00	2	"	2½	2700	5	10
45	1½ hrs.	48	12	2.00	6.00	1.00	5.00	5	"	8	2700	5	10
46	1½ hrs.	48	12	2.00	6.00	1.00	5.00	6	"	9	2640	5	8
47	1½ hrs.	48	12	2.00	6.00	1.00	5.00	6	"	9	2640	5	8
48	1½ hrs.	48	12	2.00	6.00	1.00	5.00	4	"	.....	2730	5	11
49	1½ hrs.	48	12	2.00	6.00	1.00	5.00	4	"	.....	2790	5	13
50	1½ hrs.	56	14	2.00	6.00	1.00	5.00	6	"	6	2850	5	15
51	1½ hrs.	56	14	2.00	6.00	1.00	5.00	5	"	7	2850	5	15
52	1½ hrs.	64	16	2.00	6.00	1.00	5.00	6	"	5½	2880	6	0
53	1¾ hrs.	64	16	2.00	6.00	1.00	5.00	5	"	.....	2880	6	0
54	1¾ hrs.	64	16	2.00	6.00	1.00	5.00	2	"	3	2970	6	3
55	1¾ hrs.	64	16	3.00	7.00	1.00	5.00	1	"	3	2970	6	3
56	1¾ hrs.	64	16	3.00	7.00	1.00	5.00	1	"	2	3030	6	5
57	1¾ hrs.	64	16	3.00	7.00	1.00	5.00	3	"	5	3030	6	5
58	1¾ hrs.	64	16	3.00	7.00	1.00	5.00	1	"	.....	3090	6	7
59	1¾ hrs.	64	16	3.00	7.00	1.00	5.00	3	"	.....	3120	6	8
60	1¾ hrs.	64	16	3.00	7.00	1.00	5.00	1	"	.....	3210	6	11
61	1¾ hrs.	64	16	3.00	7.00	1.00	5.00	3	"	.....	3150	6	9
62	1¾ hrs.	64	16	3.00	7.00	1.00	5.00	5	"	.....	3240	6	12
63	1¾-2 hrs.	64	16	3.00	7.00	1.00	5.00	2	"	.....	3240	6	12
64	1¾-2 hrs.	64	16	3.00	7.00	1.00	5.00	2	"	.....	3270	6	13
65	1¾-2 hrs.	64	16	3.00	7.00	1.00	5.00	2	"	.....	3270	6	14
68	1¾-2 hrs.	64	16	4.00	7.00	1.00	5.00	2	"	.....	3300	6	15

At six months weighed 7080 grammes (14 pounds 12 ounces) and was taking 150 c.c. (5 c

TEMPERATURE OF RECTAL).		PULSE.	RESP.	TEMPERATURE OF INCUBATOR.		REMARKS.
° F.				° C.	° F.	
99.5	135	60		32.2	90	Nails formed. No lanugo. Heart normal. Lungs normal. Emaciated. Cry feeble.
				32.2	90	Uric acid on napkin. Food heated to 75° C. (167° F.).
				32.2	90	Somnolent.
				32.2	90	No uric acid. Fed with dropper.
102.5		50-60		32.2	90	Temperature went up in evening. Perspired freely. Temperature of incubator lowered to 28.8° C. (85° F.). Hiccough relieved by brandy.
99.5				28.3	83	Respirations irregular; 10 quick and then imperceptible for 10 seconds. Cord fell. Somnolent.
				26.6	80	Cry a little stronger. As still perspiring a little, temperature of incubator reduced to 26.6° C. (80° F.).
				26.6	80	Slight ophthalmia neonatorum. Icterus neonatorum. Black cloth over lid of incubator.
				26.6	80	Somnolent.
				26.6	80	Less icterus.
99.5	120	60		26.6	80	Hiccough.
100.5	120	60		26.6	80	Hands and feet cold.
				26.6	80	Hands and feet warmer. Oxygen in fresh-air-box for 10 minutes three times daily. Seems hungry.
				28.8	84	Every other feeding takes 2½ drs. Oxygen as on 13th.
				28.8	84	Oxygen as on 13th.
99.0	120	60		29.4	85	Oxygen 5 minutes twice daily. Feet cold when incubator below 29.4° C. (85° F.).
98.8				29.4	85	Less icterus.
				29.4	85	Oxygen.
				29.4	85	
				29.4	85	Very hungry. Oxygen.
				29.4	85	
				29.4	85	Oxygen.
				29.4	85	Occasional cyanosis.
				29.4	85	
				29.4	85	
				29.4	85	Oxygen.
				29.4	85	
				29.4	85	
98.5				28.3	83	Brandy 5 drops every 2 hours.
						Feet and hands not cold except when temperature of incubator as low as 26.6° C. (80° F.). Seems hungry.
				28.3	83	Oxygen. Brandy 5 drops three times daily.
98.5				28.3	83	Brandy 5 drops three times daily. Oxygen. Began to feed with nipple.
98.8	140	40		26.6	80	Respirations deeper and more regular. Slight cyanosis. Oxygen.
				29.4	85	
				29.4	85	
				26.6	80	Oxygen. Brandy 5 drops.
				26.6	80	
101				26.6	80	Oxygen. Brandy 5 drops every other feeding.
				26.6	80	
99	138	48		26.6	80	
99		23		25.5	78	Allowed to have a little light in incubator. Omit oxygen.
99.5				25.5	78	
101.5				23.8	75	Oxygen. Brandy. Somnolent.
100				23.8	75	No light.
98.5				23.8	75	Is brighter. Oxygen.
				23.8	75	
				23.8	75	Oxygen. Brandy.
99				23.8	75	Seems stronger. More light.
98				23.8	75	Oxygen.
99.5				23.8	75	Brandy.
99.5				23.8	75	Seems hungry.
99				23.8	75	Oxygen.
99				22.2	72	Omit oxygen.
99				22.2	72	Sleeps well. Does not cry. Seems stronger and brighter, and is tranquil.
99				22.2	72	Does not cry.
				22.2	72	
				21.1	70	Very bright and tranquil.
				21.1	70	
				21.1	70	Taken out of incubator. Cried 9 hours. Vomited. Put back into incubator.
				21.1	70	
						Tranquil. Does not cry.
						Taken out of incubator and washed in water at 35° C. (95° F.).
99						Sleeps well. Does not cry. Is growing stronger.
						Thriving. Brandy omitted.

at each meal. Looked bright, had a good color, and was well developed and vigorous.





of the box there is a pipe by means of which the boiler can be filled with water. A stop-cock allows the water to run off from the boiler when it is necessary to empty it, or to regulate the heat of the water by allowing the cold water to flow out and warm water to replace it. A lamp of any kind placed under the arm of the pipe which comes from the boiler keeps up and regulates the warmth of the water in the boiler. I would here call attention to the fact that when the source of heat is outside of the incubator there is a danger that the free flame may set fire to the nurse's dress.

Above the boiler is a shelf, on which the infant's bed is placed, sufficient space being left between the ends of the bed and the box for a free circulation of the contained air.

A thermometer is attached to the water apparatus of the boiler, and indicates the heat of the water.

A thermometer is attached to the lid of the box, and is intended to show the temperature of the air in the box.

I have here a picture (Fig. 80) of an infant (Case 110, page 306) in this incubator, prematurely born at about the thirtieth week of intra-uterine life.

The lid of the incubator is open, representing a time when the infant is to be fed. On the left of the incubator part of the oxygen tank is shown. On a table beside the incubator are the measuring glasses, a glass tube with a cotton stopper containing the infant's food, which was prepared at the Milk-Laboratory, a pitcher of warm water to keep the food warm, and the teaspoon with which the infant was fed. In the bed beside the infant you will see that there is another thermometer, which it was found necessary to use, as the thermometer attached to the lid was subject to such variations in temperature through the glass, according to the variations of the temperature in the room, that it did not indicate exactly the temperature of the air by which the infant was surrounded. In the treatment of this infant in the incubator much difficulty arose in keeping the ventilation perfect, and at times the air for hours had to be forced through the air-box by fanning the air through the holes of entrance.

This infant was taken care of in an unusually exact way, and with such intelligence on the part of the nurses and parents that the details of its life in the incubator become of extreme value in our study of the treatment of this class of cases. I shall therefore describe the details of its existence in the incubator from the time when it was born until it was sufficiently developed to be safely taken care of in the ordinary way.

The infant and its mother were under the care of Dr. George Haven and Dr. W. L. Richardson, with whom I saw it in consultation in the early hours of its life and by whom it was placed in my charge. At birth its nails were fairly developed. Its face was not especially wrinkled, but its body and limbs did not show much evidence of subcutaneous fat. The lanugo was not present. Its weight was 2040 grammes (about  $4\frac{1}{4}$  pounds). On comparing this weight with the weights given in this table (Table 2, page 49) of the relation of weight to vitality, you will see that it is representative of that of an infant at term of very low vitality. The heart and lungs were normal. No cardiac souffle was heard over the area of the foramen ovalc. The cry was rather feeble. The infant was very somnolent.

I think you will be able to understand the details of this case most clearly if I arrange them for you in the form of a table (Table 82).

The table records the details of the infant's life in the incubator during a period of sixty-four days. The record will, I think, be of great use to

any one who has charge of a premature infant in an incubator, as it illustrates exactly what emergencies are likely to arise and how they can be met.

The infant, as is seen by referring to the column of remarks, came very near dying a number of times, and unquestionably would have died had it not been carefully managed, as, for example, by the administration of oxygen, by prompt changes in its food, by the regulation of the temperature of the incubator, and by the constant attention of a day nurse and a night nurse.

I have now in a general way told you the main facts which are known about premature infants, and the results of my experience with this class of cases. The last case (Case 110) which I have described as being treated in Dr. Woreester's incubator was the one from which I learned how very inadequate are our usual methods of treating premature infants. In the direction of this case I received so much information as to the mechanical management of the many difficulties which were continually presenting themselves in the daily care of the apparatus from Mr. J. P. Putnam, that it was at once impressed upon me that a domicile in which an infant might have to live for several months should be devised and regulated as to its ventilation and general practical usefulness even more carefully than the houses in which adults live. This meant that such apparatus needed the skilled attention of an expert in building and in ventilation. I therefore placed in Mr. Putnam's hands the construction of what I prefer to call a *brooder*. I am also indebted for many valuable suggestions as to the construction and use of the brooder to Mr. G. E. Gordon, who has had considerable experience in preserving the lives of premature calves.

Before inspecting the brooder more closely I should like you to examine this table (Table 83), in which I have condensed what I have already told you concerning the requirements needed to preserve the lives of premature infants.

TABLE 83.

*Indications for conserving the Viability of Premature Infants.*

I. There should be a receptacle which shall guard the infant from the deleterious influences of extra-uterine life.

II. There should be an apparatus that can be obtained quickly and transported rapidly, and which therefore should be kept at some central and convenient station.

III. The place where the brooder is kept should be free from the influence of any disease.

IV. The brooder should be so constructed as to make it possible for it to be absolutely cleansed and disinfected each time after it has been used, hence it should be made of metal.

V. The brooder should, as soon as the infant is placed in it, be under the observation of trained nurses night and day.

VI. The food for the infant should be regulated with the greatest precision, with the closest attention to minute details, and, if possible, at a milk-laboratory.

These are the principal rules which should be attended to where the physicians of any community wish to provide the best means for preserving the lives of the premature infants in that community. The expense of such



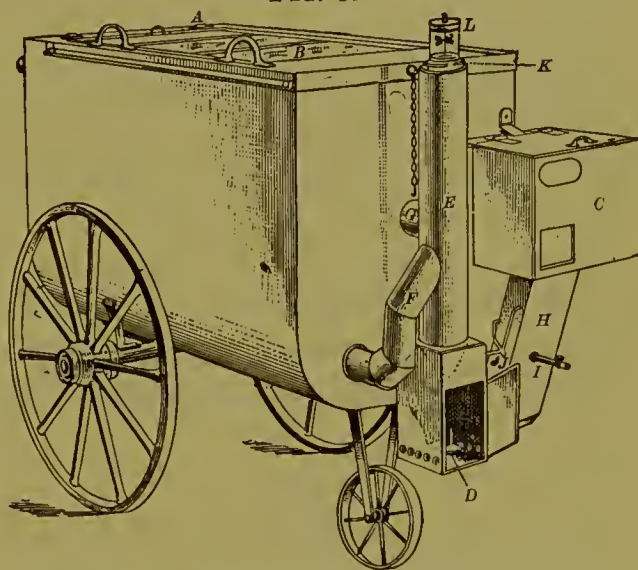
means, while too great for any one individual, is comparatively insignificant for a number. The brooder at present must necessarily be an expensive machine, but if provision should be made for it in combination with such scientific facilities for infant feeding as I have already recommended, I believe that any community would find it of infinite benefit. I am also sure that there would result saving of life for the people, and saving of time and expense for the physicians, combined with the greatest satisfaction to both people and physicians. Such a combination, in cities of a milk-laboratory or in the country of a Babcock milk-tester with a brooder kept in one central station, I hope to see established everywhere. One such station for districts which might be included in a radius of ten or even of twenty miles would be amply sufficient to accomplish very favorable results.

**BROODER.**—You will now, I hope, appreciate that it is often quite necessary to provide not merely a receptacle but an actual habitation for premature infants during a period of months. Such a habitation, which I prefer to call a *brooder* in order to represent it by the name which explains it rightly, I have here to show you (Fig. 81).

This apparatus has been made to fulfil the conditions of a house for the premature infant, and it practically meets the indications called for in this table (Table 83, p. 308). After being used, it can be completely disinfected and cleansed. It is kept at the Milk-Laboratory, whence it can be obtained at a moment's notice. For purposes of disinfection, and that it may not absorb micro-organisms or dirt of any kind, which in wooden receptacles invariably cause a decided odor, it is made entirely of metal.

The brooder is supported, as you see, on three wheels, preferably made of light steel, two behind and one guiding wheel in front. A handle is used to push it to different parts of the room, or, if necessary, to an adjoining room, so that the mother can see her infant if she is too sick to leave her bed. The top of the brooder is about 91 cm. (3 feet) from the floor, so that the nurse does not have to stoop unnecessarily, but at the same time can, when sitting down, see into it from above. It is 76 cm. (2½ feet) wide and 91 cm. (3 feet) long. The body is made of copper; the walls are double, and insulated on the outside, to prevent radiation. The water used

FIG. 81.



Brooder for premature infants. *A*, scales for weighing infant; *B*, glass lid of incubator; *C*, fresh-air box, containing clock-work and fan; *D*, lamp for heating water-jacket; *E*, chimney; *F*, return flue from heating-flues; *G*, return fresh-air flue; *H*, entrance for fresh air; *I*, connection for oxygen tank; *J*, mixing-valve; *K*, ventilating exit; *L*, anemometer.



for heating circulates on all sides, and the infant is thus warmed by direct radiation. The top of the brooder is covered in the middle by a thick plate-glass lid, which can be raised sufficiently to allow the hands and arms of the nurse to be freely used in the brooder, and is by a simple contrivance kept from falling down while the infant is being fed or touched. A chain prevents the lid from falling backward. On the under side of the glass lid is a fine wire sliding screen, which comes directly over the infant's head and between it and the glass. This is simply a precaution against the possible breakage of the glass lid and consequent injury to the infant.

This plated box (*C*), which you see attached to the upper front end of the brooder contains some strong clock-work with a fan attachment. This oval opening in the clock-box admits the air to the brooder. Below the opening for the fresh air is a window, through which the fan and clock-work can be watched.

Just below the air-opening and above the clock-work is a fine open wire shelf, on which is spread a thin layer of cotton-wool. The air, which by means of the fan is drawn into the box, is sifted through the cotton and carried down the air-shaft (*H*) directly into the brooder. In this air-shaft (*H*) you see there is a small stop-cock (*I*). This is the point of attachment for the tube from the oxygen tank, to be used when oxygen is needed to be mixed with the entering air-supply.

In this air-shaft, also, is attached a valve, which is so regulated by a register handle that the air can be utilized either above or below the boiler, according as it is needed and as I shall explain later.

The bottom of the brooder constitutes an air-chamber, and in this is a boiler which, with its heating or combustion direct and return flues, warms the interior of the apparatus.

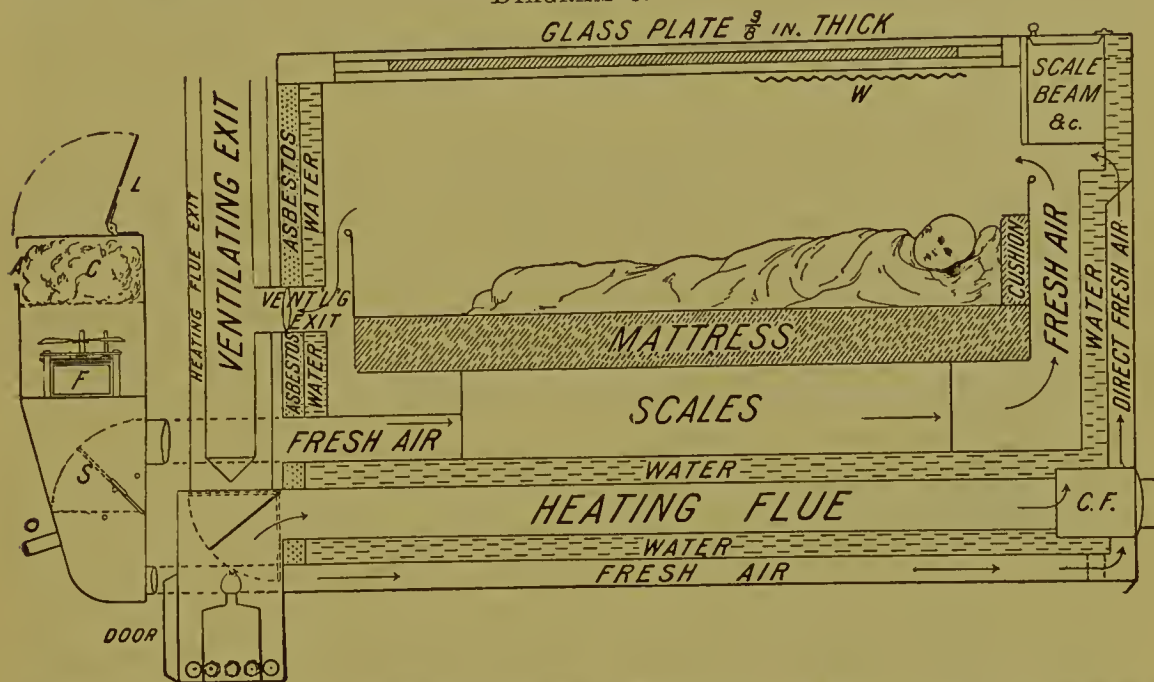
Above the boiler is placed the platform of a scale. The balance power of this scale is on the top of the back end of the brooder. The platform of the scales acts as the support for a metal pan 61 cm. (2 feet) long and 30.5 cm. (1 foot) wide, on which the infant is placed. This pan should be made of sheet iron, enamelled on both sides with white porcelain enamel, and should have handles at either end to facilitate its removal from the brooder. From the ends of this pan is hung by wires, which can be easily attached or detached, a light frame made of four steel rods crossed. On this frame is tied with tapes a piece of strong cotton cloth. This cloth is the infant's bed, on which it is placed wrapped in clean absorbent cotton. This cotton cloth is about 2.5 cm. (1 inch) above the bottom of the pan. The infant's head is turned to the back end of the brooder.

At the front end, opposite the foot of the infant's bed, is the exit (*G*) for the vitiated air. This exit passes through the end of the brooder and enters a ventilating pipe which has at its top an anemometer (*L*). The bottom of the shaft is outside the brooder, and has a closed cone-shaped end, which is enclosed in a metal box in such a way that a lamp (*D*) can be placed under it. The heat from this lamp answers two purposes. One is,

by keeping the ventilating shaft hot, to aid the ventilation, and the other is to heat the water in the boiler. A register-valve (*J*) attached to the pipe can shut off the heat if necessary from the boiler, and allow it to go directly up the double pipe (*E, K*), whereby its entire power will be used in promoting ventilation, or the valve may be set so as to direct the flame partially into the boiler, thus placing its temperature completely under control. In this way the heat from the lamp (which is enclosed in the box) is without danger entirely utilized for heating and ventilation.

I have now shown you the brooder and its general features. I shall still further explain to you its mechanism by means of this sectional diagram (Diagram 6).

DIAGRAM 6.



Section of brooder. *L*, lid of fresh-air box, open; *A*, entrance of fresh air; *C*, cotton, resting on wire shelf above clock-work; *F*, clock-work and fan; *S*, valve regulating hot and cold fresh air; *O*, pipe for oxygen attachment; *C. F.*, cleaning-flue; *Door*, door to lamp-box; *W*, wire frame to protect against breakage of lid.

The smoke-flue of the lamp, marked "Heating Flue," passes through the centre of the boiler, marked "Water" in the diagram, as far as to the cleaning-flue, marked *C. F.* Thence it returns and enters the upright pipe marked "Heating Flue Exit." The horizontal return-flue is not shown in the diagram, because it is behind the horizontal arm shown. The little gate-valve shown directly above the lamp regulates absolutely the amount of heat which is allowed to pass through the boiler, and the temperature of the warm water therein may be tested by a chemist's thermometer, inserted at any opening which may be provided for it as directed when the brooder is built.

The fresh-air flues are constructed, as shown, one above and one below the boiler. One flue comes in contact with the upper or hottest part of the boiler, and presents a very large surface of contact therewith by being flattened so as to cover completely the upper side of the boiler. The other flue touches the bottom of the boiler only in one line, or not at all, so that



the air passing through it is practically unaffected by the boiler heat. By this arrangement the temperature of the fresh air can be regulated at will by the attendant by simply raising or lowering the valve *S*.

In virtue of the large amount of heating surface of the heating flue in this apparatus, it is found that a very small flame suffices to keep up the desired temperature, and it results from this that no injurious products of combustion contaminate the air of the room. A very small alcohol lamp can be used, while with a less scientific arrangement this fuel might be found too expensive.

It is probable that an electric current will be found most suitable to supply the heat in place of the lamp, as well as to drive the fan, and this can be very easily accomplished with a small battery.

By packing the water-jacket with asbestos, external radiation is prevented.

The heating of the brooder varies as to time and degree according to the atmosphere of the room where it has been standing. If, however, the temperature of the room is  $21.1^{\circ}\text{C}$ . ( $70^{\circ}\text{F}$ .), and the temperature of the water which is introduced into the boiler is about  $40.5^{\circ}\text{C}$ . ( $105^{\circ}\text{F}$ .), it will be found that after the cool air in the brooder has been displaced the temperature of the air in the brooder will in about fifteen minutes rise to  $35^{\circ}\text{C}$ . ( $95^{\circ}\text{F}$ .). The temperature will remain at this point for about half an hour. As soon as the temperature begins to fall the alcohol lamp should be lighted, and as soon as the temperature of the water in the boiler rises above  $35^{\circ}\text{C}$ . ( $95^{\circ}\text{F}$ .) the lamp should be extinguished. By careful regulation of the lamp and regulating the fresh air by means of the register-valves, an intelligent nurse can keep the temperature of the brooder at whatever degree the physician orders. The thermometer should, in order to show accurately the temperature of the air which the infant is breathing, be beside it on its bed, as when attached to the lid it is influenced by changes of temperature in the room.

If any difficulty arises from the temperature not responding quickly enough to the register-valves and lamp, it is well to draw off a little hot water and replace it by some cold water if it is desired to lower the temperature, while to raise the temperature the withdrawn water is to be replaced by hot water.

NURSES.—The brooder is not intended to obviate the necessity of skilled nursing. On the contrary, a nurse should be in constant attendance night and day. She should have all the details of the infant's care and the mechanism of the brooder explained to her minutely, for an emergency may arise at any time, and always requires to be dealt with immediately.

The brooder supplies the means for exact treatment, but intelligent minds and trained gentle hands are indispensable. The nurse should frequently observe the infant through the glass lid, and should be certain that the anemometer is in constant motion.



APPARATUS CONNECTED WITH THE BROODER.—A stethoscope like this one (Fig. 85, p. 323) is the best adapted for examining the infant in the brooder. It can be bent in any direction, and the small calibre of its cup is best adapted to the infant's size.

A piece of dark cloth should be kept over the glass lid, to preclude the light, while the sun should be allowed to shine freely into the room.

The method of feeding the infant in the brooder is important. It frequently happens that the premature infant is too weak not only to suck the breast, but also to be fed from the bottle. In such cases it is customary to use a spoon or a medicine-dropper. These, however, are very unsatisfactory instruments. The food is liable to be spilled, the spoon or dropper has to be frequently filled, and much time is taken to complete the feeding. The lid of the brooder, also, should not be kept open for a longer time than is unavoidable.

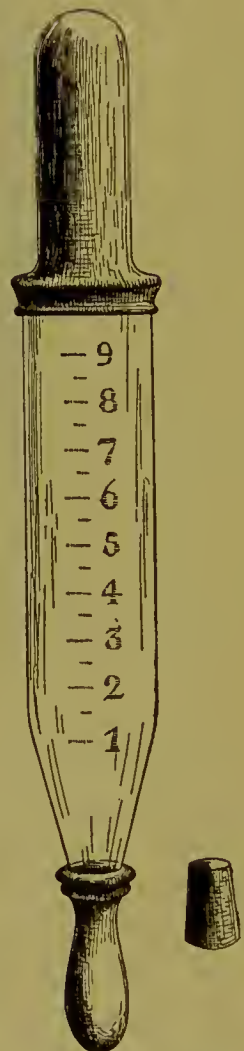
I have lately made use of a device suggested by Dr. Bree, who first brought it to my notice when I was seeing a premature infant with him in consultation where there was much difficulty in getting the infant to swallow, and where it would not suck.

It is simply this glass cylinder (Fig. 82), 12 em. ( $4\frac{3}{4}$  inches) long and 2.4 cm. (1 inch) in diameter. The cylinder is graduated to 2 c.c. ( $\frac{1}{2}$  drachm), and holds 36 e.e. (9 drachms). It is shaped at one end so as to have a small rubber nipple fitted to it. The large end is covered by a rubber cot. The rubber cot, which has no holes, acts as an air-reservoir, and by simply introducing the small perforated nipple into the mouth and gently pressing the rubber cot the food is slowly forced down the infant's throat, without choking it and without the infant having to suck or apparently to use any effort. To fill the tube the rubber nipple and cot are removed, a rubber stopper like this (Fig. 82) plugs the small end of the cylinder, and the required amount of food is poured in at the large end.

This method of feeding is especially desirable for a weak premature infant in a brooder, because it entails no loss of strength on the part of the infant, and can be easily managed by the right hand of the nurse while her left hand supports the infant's head. This method is far preferable to that of gavage, which is not so easily managed by the nurse and causes more exhaustion to the infant.

The question is often asked whether premature infants, even if their lives are saved, can be as well developed physically and mentally as are those born at term. In my experience, there seems to be no question that when once we have succeeded in making the

FIG. 82.



Feeder for premature infants (reduced one-half).

infant gain steadily in weight and assume the appearance of an infant at term its subsequent condition differs in no respect from that of infants born at term.

I have here to show you a picture of the infant (Case 110, p. 307) which was treated in Dr. Worcester's incubator.

FIG. 83.



Infant premature at thirty weeks. Birth-weight, 2040 grammes. Treated in incubator sixty-four days. Present age, nine months. Present weight, 8400 grammes.

This picture was taken when the infant was nine months old, and it weighed at that time 8400 grammes ( $17\frac{1}{2}$  pounds). As its birth-weight was 2040 grammes (about  $4\frac{1}{4}$  pounds), you see that it has quadrupled its weight. It was fed entirely on modified milk from the Laboratory during the first year, and is now a fine large boy, walking and talking at two years of age. It is perfectly healthy and well developed both physically and mentally.

His sister, who was premature at the twenty-eighth week, is now eight years old. She is well developed and strong, and is unusually bright and intelligent for her age. She is, in fact, decidedly in advance mentally of the other children of her age at her school.

I have here the record of an infant prematurely born at about the thirtieth week, and weighing 2850 grammes (about 5 pounds 15 ounces), which was the first premature infant that happened to be treated in this brooder (Fig. 81, page 309).



This infant (Case 111) was born at ten minutes past three on February 16. It was placed in the brooder at 9 P.M. of the same day, the temperature of the brooder being 34.4° C. (94° F.).

On the following day, February 17, the infant was given by the nurse 4 c.c. (1 drachm) of diluted cow's milk every hour for three feedings, which he vomited almost immediately after taking. The intervals of feeding were then increased to two hours, but the milk was not retained. The nurse then gave him 2 c.c. ( $\frac{1}{2}$  drachm) every three hours during the night, which he retained for a number of feedings, but then vomited bile and mucus, together with the undigested food which had been given him.

February 18 the infant was found to have lost 420 grammes (14 ounces) in weight, to be very weak, and to be unable to retain the milk diluted with water. The meconium came away on this day, and there was a uric acid stain on the napkins. The infant was very restless. Its respirations were irregular, and its feet and hands were cold. The temperature of the brooder, which up to this time had been kept at 34.4° C. (94° F.), was lowered to 33.8° C. (93° F.), as the infant had begun to perspire. A substitute food was ordered from the Milk-Laboratory on this day, the prescription for which was as follows (Prescription 36):

PRESCRIPTION 36.

R Fat . . . . .	1.00
Sugar . . . . .	3.00
Proteids . . . . .	0.50
To be heated for thirty minutes at 75° C. (167° F.).	
Lime water . . . . .	5.00
24 tubes, each containing 4 c.c. (1 drachm).	

This food was given to the infant every hour.

On the following day, the 19th, the record was that the food had been retained, that the infant had seemed so hungry that the amount had to be increased to 10 c.c. ( $2\frac{1}{2}$  drachms), and that it was found advisable to feed it every two hours rather than every hour. There was no vomiting. There were two movements of the bowels, which still showed evidences of undigested milk and some meconium. The infant's weight on this day was found to be the same as on the previous day, 2300 grammes (5 pounds 1 ounce).

On the following day, February 20, the infant was found to have gained 30 grammes (1 ounce). It was taking its food regularly every two hours, alternating with the mother's milk, which had come in considerable quantity. There were still evidences of uric acid in the urine. The temperature of the brooder was kept at 31.6° C. (89° F.).

On the following day, February 21, the weight was as on the previous day, 2230 grammes (5 pounds 2 ounces). The color of the faecal discharges was yellowish brown. There was only one discharge in the twenty-four hours, obtained by the use of a suppository. The temperature of the brooder was kept at 30° C. (86° F.).

On the following day, February 22, it was found that the infant had lost 60 grammes (2 ounces). The substitute food was then given every two hours, alternating with the breast-milk. On that day there were three yellow well-digested movements. The temperature of the brooder was kept at 29.4° C. (85° F.). The infant seemed stronger, was very quiet, and slept except when it awoke to receive its food.

On the following day, February 23, there is no record of the infant's weight, but it was evidently in a very precarious condition and seemed exhausted. It did not take its nourishment readily. It had five small faecal discharges in the twenty-four hours, which, however, were yellow and fairly digested.

On the following day, February 24, the breast-milk was omitted, and 4 c.c. (1 drachm) of modified milk were given every two hours, the percentage of the sugar being raised from 3 to 3.5. There were four small faecal movements during the day; the first one was green, the last three were yellow and decidedly better digested. The temperature of the brooder was kept at 29.4° C. (85° F.). During the day the infant gained 60 grammes (2 ounces) in weight. It was so weak on these two days that it would have been dangerous to take it out of the brooder to weigh it, so that the continual record of the weight which



could be obtained by the scale-bed of the brooder was of the utmost value in regulating the changes in the food necessary to save the infant's life.

On the following day, February 25, the infant's weight was found to be 2260 grammes (5 pounds 3 ounces), an increase of 30 grammes (1 ounce). The percentages in the modified milk were then changed to the following (Prescription 37):

PREScription 37.

R Fat . . . . .	1.50
Sugar . . . . .	4.00
Proteids . . . . .	0.75

One drop of brandy was given with each feeding. There was one faecal discharge, which was yellow and well digested. On this day 4 e.e. (1 drachm) of food were given to the infant every two hours until its feeding at 10.30 P.M. After this it seemed so hungry that at midnight 36 e.c. (9 drachms) were given, at 3 A.M. 40 e.c. (10 drachms) were given, and at 5.30 A.M. 30 grammes (1 ounce) were given. The weight was now found to be 2420 grammes (5 pounds 5 ounces), an increase of 60 grammes (2 ounces) in the twenty-four hours. The amount of food which the infant had taken in the previous twenty-four hours was found to have been 375 grammes (12½ ounces). The faecal discharges were yellow and well digested. Brandy was continued to be given. The temperature of the brooder was kept at 29.4° C. (85° F.). At times a little breast-milk was given to the infant, in order to satisfy the mother, but it evidently did not agree with it.

On February 27 the weight was found to be 2450 grammes (5 pounds 6 ounces). The prescription for the modified milk was then changed as follows (Prescription 38):

PREScription 38.

R Fat . . . . .	2.00
Sugar . . . . .	5.00
Proteids . . . . .	0.75

30 grammes (1 ounce) of this were given to the infant every two hours during the day, and every two and one-half hours during the night. One yellow well-digested faecal discharge was obtained by means of a suppository. The temperature of the brooder was then reduced to 27.7° C. (82° F.).

The following day, February 28, the weight was found to be 2480 grammes (5 pounds 7 ounces). The brandy was still continued, and there was one yellow well-digested faecal discharge. The breast-milk had been entirely omitted, and 450 grammes (15 ounces) of modified milk had been taken in the twenty-four hours.

On the following day, March 1, it weighed 2510 grammes (5 pounds 8 ounces). The amount of modified milk given was 495 grammes (16½ ounces) in the twenty-four hours, and one drop of brandy was given with each feeding. There was great improvement in the infant's appearance, and it was much stronger.

On the following day, March 2, there had been no increase or loss in weight. The temperature of the brooder was kept at 27.2° C. (81° F.). 510 grammes (17 ounces) of the modified milk were taken in the twenty-four hours. There was one faecal movement, well digested and yellow.

On the following day, March 3, the weight was found to have increased to 2600 grammes (5 pounds 11 ounces). The percentages of the modified milk were then changed to the following (Prescription 39):

PREScription 39.

R Fat . . . . .	2.50
Sugar . . . . .	5.00
Proteids . . . . .	1.00

There were two well-digested faecal discharges on this day. The temperature of the incubator was reduced to 25° C. (77° F.). 615 grammes (20½ ounces) of the modified milk were given in the twenty-four hours.

The following day, March 4, the infant was found to have lost 60 grammes (2 ounces), and the temperature of the brooder was therefore raised to 26.6° C. (80° F.). 630 grammes (21 ounces) of modified milk were taken in the twenty-four hours, and there was no especial change in the infant's condition.

On the following day, March 5, 30 grammes (1 ounce) in weight were found to have been gained, and the infant was looking better and decidedly gaining in strength. It was evident that the proper temperature for this especial infant at this age and at this period of its development was 26.6° C. (80° F.).

After this time the infant continued to develop normally, and on being taken out of the brooder in April was thriving in every way.

It is now five months old, and weighs 7110 grammes (14 pounds and 13 ounces).

## DIVISION VI.

### GENERAL PRINCIPLES OF EXAMINATION AND TREATMENT.

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#### LECTURE XIII.

##### METHOD OF EXAMINING A SICK CHILD.—DRUGS.

BEFORE beginning in detail the actual study of the various classes of disease which I shall later present to you for examination, I should like to have you understand a few of the general principles a knowledge of which I consider of importance in dealing with sick children.

When a physician is called to see a sick child, he must, if possible, ascertain before entering the nursery what is the temperament of the child with whom he will have to deal, and by the aid of this information regulate the manner in which he approaches it.

An infant in the early months of life too young to fear a stranger, a child of quiet phlegmatic temperament, or one that is too sick to object to being handled, can be examined as soon as it is seen, with the regularity and precision which one would employ with the adult.

It is an entirely different task, however, when one is called upon to examine children who are nervous, excitable, or timid, or who are spoiled and vicious. In dealing with the first and more difficult class of these cases much deliberation in the way in which you approach the child is needed, and much diplomacy in speaking to it is indicated. In the second, the spoiled and vicious class, you will not gain time by delaying the examination, and the sooner you have made it with firmness and persistence the less trying it will be for the child and for the mother. As a rule, the more the child cries and resists needlessly, the less likely is it to have any disease of serious import.

You will find that it is wise at first to make the child think that you are not taking any notice of it, and that you are not even aware of its presence. It is well to notice its toys, and to appear to take great interest in them and also in the pictures in the nursery. The child very soon will become accustomed to your presence, and will begin to take the



same interest in you that you seem to take in its toys. A nervous, timid child will often from this point of the examination allow you to examine it without further trouble.

The physician, however, must always be gentle both in his voice and in his touch, and on the slightest appearance of timidity, or manifestation of a desire to avoid him, he must at once stop the special part of the examination which he is making, and devote himself again to the child's toys.

All these preliminaries and minute details, which seemingly delay the examination, in fact expedite it, since when once the timid child is thoroughly frightened, the rest of the examination becomes very unsatisfactory, for it is almost cruel in cases of this kind to attempt to force an examination, which in the case of the vicious child can be done usually without this feeling of cruelty and without hurting the feelings of the mother.

You should acquire the faculty of examining the child when it is crying and excited with the same precision as when it is quiescent, though perhaps by a somewhat different method. The trained hand and ear can detect an abdominal or pleuritic effusion or a solidified lung almost as well when the child is screaming as when it is perfectly docile.

This is an accomplishment which should be mastered at once by every practitioner who expects to have children under his care. In fact, if this were more universally understood, we should hear less of the impossibility of determining what is the matter with a child on account of its being fractious.

As the physical examination of a child is somewhat more difficult than that of the adult, and requires to be made more quickly, you should make use of every means at your command which will tend to throw light on the final result.

**HISTORY.**—A complete history of the case is very valuable, and should be obtained from the mother and the nurse, preferably before seeing the child, for in this way the physician can obviate asking many questions in its presence, a procedure which frequently fatigues it and renders it more difficult to examine. It is well to allow the mother and the nurse to tell you in their own language what they know about the child and its sickness. After they have finished, you can easily systematize the history of the case by any questions which you may wish to ask. Although the history given by the mother and the nurse is usually imperfect and disconnected, yet it is very likely to supply certain important points which you in your questions might easily overlook. The mother and the nurse are so constantly with the child that they notice all the slight shades of difference in its condition from hour to hour, a knowledge of which is of great importance in obtaining a correct appreciation of the general condition of the child, whatever the disease may be.

Having now systematized in his own mind the history of the case, the physician on entering the nursery should proceed with his inspection of the child. I am supposing that the child is in one of the two classes which I have mentioned as being especially necessary to manage with diplomacy.

**TEMPERATURE.**—Of course it is so important to ascertain what the temperature of the child is that, if possible, the temperature should be taken before the child has become frightened or fractious. The place for taking the temperature in these cases is usually in the axilla. You will find that the most successful method of obtaining the temperature under these circumstances is to explain to the mother and nurse exactly what you wish to have done. You should direct them to take the thermometer and show it to the child as though it were a toy, to put it under the child's arm, and to play with the child until you tell them to remove the thermometer. A rectal temperature is always desirable when it can be obtained, as it is more exact.

**INSPECTION.**—One of the most valuable means of making a diagnosis of disease in children is the careful inspection of the child before attempting to percuss or to auscult it. In fact, where children are irritable and restless the inspection becomes of the utmost importance, and an eye which has been trained to understand the different aspects of disease in children readily makes the diagnosis in many cases without further assistance. A rule to be remembered, and one which you will find of great practical value, is, if possible, to have the child entirely undressed, so that you can see the whole surface of its skin in front and behind. Not only will you thus be able to recognize the symptoms attributable to a simple irritation of the skin, where otherwise you might be led to consider them as representing a more general and constitutional disturbance, but you will also find the skin to be a valuable index by which you can judge of diseases of the other organs. The cyanosis which so frequently represents some disturbance in the heart or lung, the quick respirations of either a thoracic or an abdominal type, a sunken or a distended abdomen, and the position of the child, all point towards symptoms belonging to special diseases. By means of all these symptoms, which we can see at a glance, the diagnosis of the special disease can usually be made without much aid from other sources.

**RESPIRATION.**—Either when the thermometer is under the child's arm or when you are beginning your regular inspection you can usually determine the rate and rhythm of the respiration. Having determined the temperature and respiration, if you have seen all that is necessary about the child when it is quiescent, you can proceed with the remaining part of your examination.

**PALPATION.**—Palpation is a very valuable means of diagnosing disease in children, whether it be of the abdomen or of the thorax. It is well to begin with an attempt to take the pulse. Sometimes this can be readily accomplished. At other times it is impossible; and, as a rule, I rely less on the rapidity of the pulse in the child than on the information which is received from the temperature and respiration. It takes so little to increase the rate of the pulse in a young child that if we were to judge in every case by it we should often be misled in our diagnosis. What we wish especially to learn is whether there is a slow pulse or whether it inter-



mits. This we can usually ascertain by keeping our finger for even only two or three seconds on the child's radial artery. When we have once obtained a fair idea of the rate and rhythm of the pulse we can proceed with the remainder of our examination by palpation.

A young child's thoracic walls are so thin, and vibration is so pronounced in them, that often we can detect what process is going on in the lung by merely putting our hand on the chest, and we can feel in a chronic bronchitis what will prove on auscultation to be coarse sonorous râles. We can also sometimes feel a pleuritic or a pericardial friction-rub, and frequently a roughening of one of the valves of the heart. It is not altogether impossible in certain cases to distinguish the difference presented to the hand between a pleuritic effusion and a solidified lung. The examination of the abdomen, even when the child is crying, can be accomplished with considerable precision. Waiting until the child stops crying for a second and relaxes its abdominal walls, you can, by firm but gentle pressure, so depress the abdominal walls as to obtain a fair knowledge of whether you have an abdominal tumor to deal with. You can also readily detect by palpation fluid in the abdominal cavity.

A rectal examination is often important in infants and young children. It can readily be done without hurting the child, and the finger is able to reach much further proportionately into the child's pelvis than into that of the adult, and very much more can be learned by this method than in adult cases. An invagination or an appendicitis can be diagnosticated by the combined examination through the rectum and by external pressure where external palpation alone has failed to give evidence of disease.

In the infant the head should be carefully examined in regard to the fontanelles. Measurements should be taken of the head and of the thorax.

At this stage of the examination you will have determined almost always what disease is affecting the child, but you should, of course, make use of every known method for verifying your diagnosis. You should, therefore, endeavor to percuss and auscult the child, but in a somewhat different way from that which you would naturally employ with the adult. The louder the child cries, the easier is it to obtain evidence through vocal fremitus what the disturbance is in the chest.

**PERCUSSION.**—Even when the child is crying and resisting, percussion may be of the greatest importance. Light percussion, as a rule, is preferable to the deeper and heavier percussion which is often so valuable in the adult. The chest-walls, as I have said, are so resonant that deep percussion rather masks the process which is directly under the finger by bringing out sounds from all parts of the chest. Direct percussion with the finger I have always found preferable to using any instrument, as in this way both palpation and percussion may be combined. Palpatory percussion in my hands has always proved exceedingly valuable for diagnostic purposes. A few light taps over the normal boundaries of the heart and lung, which I have described to you in a previous lecture (Lecture IV.,



pages 121, 122, 124), will give you much information, even though you are unable to effect a more extended percussion of the chest. If the child is crying, you should watch until it takes its breath. Just as it draws in its breath it necessarily stops crying, and at that minute you can get a perfectly clear result from your percussion.

You should be careful not to make your physical examination too protracted. Rapidity of motion, both in palpation and in percussion, is very important, and you should learn to examine a young child with much greater rapidity than is usual or necessary in the case of an adult. You will in this way obtain much more information than if you wearied the child by continual efforts to make sure that you had not made a mistake in the evidence which you have acquired up to this point of the examination.

The sounds which can be elicited from a young child's chest are so varied that it is more difficult to differentiate them than in the adult. If, therefore, you allow yourself to hesitate and to doubt, you will not arrive at as correct a result in your examination as when you have trained your mind to grasp at once the salient points in the special physical examination, and to depend somewhat more on the first idea which you form than would be wise in the case of an adult.

**AUSCULTATION.**—I am accustomed next to auscult the child. A word may, perhaps, not be deemed unnecessary in regard to the form of stethoscope which I am in the habit of using in examining infants and young children. It is, I think, unwise to accustom yourselves to the use of one form of stethoscope, as you will often have to examine children at times when you have not your stethoscope with you, and yet when it may be of the greatest importance that a definite diagnosis of the case should be made. I have noticed that children are much more sensitive to the feeling of the stethoscope than are adults. In many cases they shrink from it as though it hurt them, even when they have not been frightened by the previous part of the examination with palpation and percussion. It is, therefore, exceedingly important to make the examination as pleasant to the child as possible. I have found that a rubber cup applied to the end of the stethoscope serves this purpose well. The feeling of the soft rubber is pleasant to the child, and it conveys the sound with almost as much clearness as does the hard rubber end of the stethoscope. This rubber cup can be applied to any stethoscope, such as this one (Fig. 84), which, however, does not convey the sound quite so clearly as does this other stethoscope (Fig. 85), which is of such small calibre that it can easily be introduced between the ribs of even a young child, and which differentiates the sounds much more clearly than is done by any other stethoscope which I have seen.

In my opinion, it is often of great aid in the proper appreciation of the sounds which are heard with the stethoscope in infants and in young children, especially when they are crying, to use a stethoscope which does not convey the sound so clearly and intensely as do others. We can often in this way differentiate a soft cardiac murmur which if a more delicate in-

strument were used would be entirely obscured by the loud sounds coming from the trachea and bronchi of a crying or screaming child. We can, also, often distinguish the fine râles of a broncho-pneumonia in contradistinction to the loud coarse râles which tend to obscure the other sounds in the chest. For a routine examination, however, and for rapidity in its completion in cases where we see that a prolonged auscultation will prove to be impossible, the smaller stethoscope (Fig. 85) is best adapted for our purpose.

FIG. 84.



Stethoscope.

FIG. 85.



Stethoscope.

**EXAMINATION OF THE THROAT.**—We have now examined the child in every way except one, which is an exceedingly important one, the omission of which might be productive of errors in diagnosis. This is the examination of the throat. I have left the examination of the throat to a time when we have practically finished with the general examination of the child, because, as a rule, it is the procedure of all others which irritates it, and after we have once attempted to examine the throat we shall seldom be forgiven by the child at that special visit. Some children will allow you to look into their throats without being at all disturbed. As a rule, however, it frightens them, and we should use the most gentle and rapid methods for accomplishing our purpose. We must not expect to be able to sit down in

front of the child and examine its throat for some minutes, as is possible with adults. We must adopt some definite method by which we can control the child and catch a glimpse of the mouth, tongue, and pharynx. The more quickly we do this, the less it frightens the child, and it is important that we should not make extensive preparations, which it will notice and which will indicate what we are going to do. The mothers are often much disturbed by seeing the child first frightened with the idea that it is going to have a spoon put in its mouth, and then, while screaming and crying, forced to the window and compelled to open its mouth. It is far better under all circumstances to tell the mother and the nurse what to do, and not to go near the child until they are entirely prepared to control its limbs and are holding it in a position in which it is practically helpless. It frightens the child much less to have it sit in the nurse's lap with its face to the window than to examine it on its back. I can illustrate best the proper method of examining a child's throat where we expect to meet with resistance, by picking out a really vicious child, and one which has been made vicious by being spoiled, for in these cases we meet with the greatest difficulty, and they are cases where diplomacy, persuasion, and delay are of no avail. I happen to have here to-day a child of this kind (Case 112).

## CASE 112.



Clinical examination of throat.

She is eight years old and well developed, and she will be determined to resist our efforts to examine her throat. My directions for examining the throat of such a child are as follows:

I do not let her see what I am going to examine the throat with, nor do I go near her until she is ready to be examined. The nurse is instructed to lead the child to a window, place a chair in front of the window, and sit down in it, with her face to the window. She then lifts the child into her lap, holding its back upright against her chest, and holds it by clasping her arms around its arms. By clasping the child's ankles between her feet



or knees, the nurse can absolutely control its movements. She cannot move her arms or her legs, nor can she slip down in the nurse's lap, but she is forced to sit upright. All she can do is to move her head. When she is once in this position I place my left hand on the top of her head, and thus control the movement of the head. She will, as you see, open her mouth, and then, watching me, quickly shut it up again just as I am about to put the handle of the spoon in her mouth. I next carefully place the handle of the spoon between the child's lips. If necessary, in cases which are very intractable, closing the nostrils will make the child open its mouth to get breath. This is usually not necessary, and all that we have to do is patiently, firmly, gently, and persistently to watch our opportunity, and take advantage of it when it comes, to introduce the handle of the spoon between the teeth, and gradually put it on the tongue. When the end of the handle of the spoon touches the soft palate the child will gag, and by steady pressure at this moment on the base of the tongue a perfectly clear view of the throat will be obtained, and in this one glance you should take in all that is to be seen.

You will thus successfully accomplish an examination in a few seconds which the mother had feared would be prolonged and harrowing.

I prefer to use a spoon for examining the throat, because in every household you have one at your command, and it obviates the use of the same instrument in a number of mouths, which is something to be considered in children, where infection by the mouth is so common. Of course, for those who prefer to use the usual tongue-depressor the danger is reduced to a minimum if a careful disinfection of the instrument is made after it is used; but in the case of infants, who should also be examined in an upright position, the spoon is decidedly preferable. This is so because the neck of the infant is so short that its chin is in close proximity to its chest, and the handle of the tongue-depressor interferes with the proper downward pressure of the instrument. The spoon-handle, on the other hand, is exactly the shape which is best adapted to the infant's mouth and tongue, and the spoon, being comparatively straight, does not encroach upon the thorax when the downward pressure is made.

In regard to the examination of the throat, this part of the child may be affected often, and may be the only source of the symptoms which you will be called upon to explain, and yet these symptoms may not be what you would expect to find where the trouble is in the throat. Young children are so apt not to complain of trouble in the throat, and to show merely signs of general constitutional disturbance, that the physician is very likely to be misled and to overlook the real seat of the disease unless he makes it a rule always to examine the throat at his first visit.

**INSPECTION OF THE MOUTH.**—It is well when the physician is examining the throat of an infant in the first two years of its life, and even later if there are any symptoms which point towards the mouth, to examine carefully the gums. I need scarcely caution you to wash your hands carefully before introducing your fingers into the mouth. This is in accordance with the common rules of cleanliness, and also is required in order that you should avoid the introduction of pathogenic organisms into the infant's mouth. In examining the gums you can judge whether they are swollen or reddened, dry, moist, or hotter than normal, and also at times, as I shall

explain to you when speaking of diseases of the mouth in children (Lecture XL., page 797), you will in this way be able to decide whether there is a condition of the gums which indicates the use of the lancet.

**EXAMINATION OF THE EARS.**—One of the most important means of rightly interpreting the symptoms of restlessness, of evident pain, of heightened temperature, of undue somnolence, as well as a great many other symptoms, is the examination of the ears of infants and of young children. A slight irritation in the throat may at times cause a congestion in the vessels of the membrana tympani which may produce all these symptoms.

It is, therefore, very important, unless you are sure that the symptoms do not arise from some condition in the ear, that you should examine the ears at some time during your visit, choosing that time which seems most favorable in the especial case. I consider a thorough knowledge of the possible symptoms which may arise from the ear of the very greatest importance for the general practitioner to possess.

**DRUGS.**—An important fact to remember in the treatment of infants and young children is that drugs play a very insignificant part in the actual cure of their diseases. According to my observation, numbers of children are being treated by drugs, and yet often, so far as I can see, this time-honored means of satisfying parental prejudices is but prolonging the symptoms of a disease which, self-limited, has run its course. I do not for a moment question the direct benefit obtained from quinine in malaria and mercury in syphilis: it is the promiscuous use of drugs in every case of sickness to which I am especially opposed, for in many cases the child will recover with equal or even greater rapidity without them.

Instances probably arise in the practice of every physician where he feels that the drugs which have been given have either directly harmed the child or, by disturbing its digestion and thus interfering with its nutrition, have indirectly produced more serious symptoms than those presented by the original disease. The greatest caution should be employed where drugs are used with young children, and there should be a thorough understanding of their action during the various periods of development. The well-known susceptibility of children to the action of opium and its alkaloids should make us careful to begin with minimum doses when it is necessary to use this drug. In like manner, although it is traditional that children have a great tolerance for belladonna and arsenic, we must allow that an overdose of the former, although not usually fatal, may certainly produce most alarming symptoms, while the administration of the latter as I have seen it given in the treatment of chorea has in a number of cases produced a multiple neuritis.

The treatment of diseases by special drugs because these drugs have been given in the past, because their administration has apparently done no harm, or because no new or better remedy has been found, rests upon a lack of comprehension of what treatment really means.



The custom of combining many drugs in one prescription is fallacious, and should be discountenanced, especially where infants and young children are being treated. A single drug given in the smallest dose which will accomplish its purpose, and in the most agreeable form which is compatible with the function of digestion, will produce the best results in any given disease.

The delicate skin of infants and young children is peculiarly sensitive to reflex disturbances caused by drugs in the gastro-enteric tract, and therefore we must be careful not to mistake the appearances produced by such reflex irritation for the various lesions of the skin which may occur in a specific disease. Thus, the similarity of the efflorescence produced by belladonna to that accompanying scarlet fever is striking. Almost any drug, as well as certain articles of diet, may in some individuals produce forms of papular erythema, resembling very closely some of the dermal lesions of syphilis. It is therefore wise to avoid these possible disturbances of nutrition by giving drugs only where they are actually known to be necessary, and by omitting them as soon as possible.

It has always seemed to me irrational to prescribe syrups as a menstruum for the administration of drugs to children. Their well-known tendency to fermentation is sufficient to stamp them as unfit for the treatment of a period of life when the undeveloped condition of the digestive function indicates the vital importance of protecting this function in every way.

Each case must be treated according to its special pathological lesion or specific micro-organism. As year by year we are discovering the organisms which cause special diseases, so the treatment of the future will be the actual destruction and speedy elimination of these organisms while supporting the strength until such elimination has been accomplished. Where no known organisms exist, the treatment should be if possible to remove the cause, and to support the vitality until natural processes have healed the special lesion, produced either by exposure or by trauma.

In connection with what I have said regarding the unnecessary use of drugs in early life, the following case is of considerable significance:

An infant five months old was reported to me to have tubercular meningitis. The history of the case was as follows:

A healthy breast-fed infant (Case 113), with a healthy mother, had been for two weeks showing signs of fretfulness, which, as afterwards proved, were closely connected with irritation of the two lower middle incisors, which were in the process of coming through the gum. The infant had had a slight cold for two days, and on the second day had been more restless than usual in the afternoon, and had screamed a great deal. The attending physician prescribed a mixture of fifteen drops of tincture of opium in thirty teaspoonfuls of water, to be given in teaspoonful doses at intervals during the night, if it was found necessary to quiet the infant. During the night the infant's hands and feet were reported to be cold, and by morning it was found to be almost unconscious. The physician at this time made the diagnosis of tubercular meningitis, and on the following day, when it was seen by me with him, it was found to have contracted pupils, cool skin, a rectal temperature of 37° C. (98° F.), a fontanelle somewhat depressed, a regular pulse, 120, and respirations quiet



and not especially slow. It did not notice anything, except when it was roused, at which time it would cry vigorously, as though it were annoyed at being disturbed.

On inquiry, it was found that the nurse during the night had given eight teaspoonfuls of the mixture which I have just mentioned. This amount must have contained at least four drops of tincture of opium.

A dose of sulphate of atropia of 0.0003 ( $\frac{1}{2000}$  of a grain) was given at once by the mouth. Four hours later the pupils became less contracted, but were reacting sluggishly. An hour later another dose of sulphate of atropia of the same strength was given, and the pupils then dilated, the infant grew brighter, and recovered within twenty-four hours.

After the second dose of atropia had been given, an efflorescence, which probably was the result of the physiological action of the atropia on the skin, appeared on the chest and face for a few hours, and the skin then became normal. This efflorescence, it is well to record, was at first mistaken for that of scarlet fever, so that in the same case an erroneous diagnosis of two entirely different diseases was made, and in each case the symptoms supposed to represent these diseases were really caused by the drugs which had been given to the patient.

## DIVISION VII.

### THE BLOOD IN INFANCY AND CHILDHOOD.

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#### LECTURE XIV.

LITERATURE.—NOMENCLATURE.—BLOOD-KEY.—METHODS.—CHEMISTRY.—ORIGIN.—FÆTAL BLOOD.—THE NORMAL CONDITIONS OF THE BLOOD IN EARLY LIFE.

As our knowledge advances regarding the etiology of disease, it is becoming very evident that we should not only direct attention to the pathology of the tissues outside of the blood, but should also investigate the varied conditions which exist in the blood itself. The blood does not merely absorb the waste matter from the tissues and carry fresh oxygenated material to replace it. It plays a far greater part in the economy than this, and is intimately connected with many diseases.

It is not only in the corpuscular elements of the blood that we find various changes corresponding to certain conditions existing in the individual. We must in the future go still further and read what the blood serum is waiting to disclose to us.

Although an immense amount of labor has been expended on examinations of the blood, both chemical and microscopic, especially in that of adults, the present state of our knowledge concerning its diseases, and its conditions as representative of other diseases, is very unsatisfactory.

Our knowledge of the blood in early life is still more meagre than at a later period. Although in the last few years the literature of the blood in general has become very extensive, yet that pertaining to infancy is small. We must, indeed, confess that what we definitely know of the diseases of the blood in the first few years of life is wanting in exactness and veiled in obscurity.

It is exceedingly important, therefore, that the results of individual investigation in this class of cases should be published as soon as possible, for the purpose of rendering mutual aid in unravelling the mysteries of this interesting subject. For many years I have met with cases which have been difficult to classify beyond their evident connection with the blood.

During the last two years I have endeavored to formulate more systematically my clinical observations on these cases, and I have been enabled

to collect some valuable data for diagnosis and prognosis. In the accomplishment of this work I have received much assistance from Dr. William F. Whitney, who has with great patience and labor differentiated the specimens as they were brought to him from the several cases on slides for microscopic examination. I wish especially to direct attention and award great merit to Dr. A. H. Wentworth's work. He has labored in this field for me unceasingly during the past two years, going to my cases, preparing the slides, and estimating the red and white corpuseles and hæmoglobin. Up to the present time very little work on infants, corresponding to Dr. Wentworth's, has been done in this country, and it is therefore especially valuable.

**NOMENCLATURE.**—The various terms used to designate the elements of the blood will soon become as familiar to the general practitioner as those now used in clinical medicine. I think, however, that you may not deem it unnecessary for me to explain to you the meaning of some of the words which I am about to use. I have endeavored to do this in the following table (Table 84), and by means of this colored plate, showing the various elements of the blood (Plate V.).

TABLE 84.

*Meaning of the Terms used in Describing the Blood.*

<b>ERYTHROCYTES</b> . . . . .	Normal red corpuseles . . . . .	(Plate V., 5.)
1. Hæmatoblasts . . . . .	Nucleated red corpuseles . . . . .	(Plate V., 6.)
of Neumann.		
(1) Normoblasts . . . . .	Size of erythrocytes, having a small deeply staining nucleus . . . . .	(Plate V., 6.)
(2) Megaloblasts . . . . .	Large nucleated red corpuseles, having a large, often fragmented, nucleus, staining faintly . . . . .	(Plate V., 6a.)
(3) Microblasts . . . . .	Small nucleated red corpuseles.	
2. Hæmatoblasts . . . . .	Blood plates, supposed by these authors to be young red blood-corpuseles.	
of Hayem and Bizzozzer.		
3. Microcytes . . . . .	Abnormally small erythrocytes . . . . .	(Plate V., 7b.)
4. Macrocytes . . . . .	Abnormally large erythrocytes.	
or Megalocytes.		
5. Poikilocytes . . . . .	Abnormally-shaped erythrocytes . . . . .	(Plate V., 7a.)
Oligocythæmia . . . . .	Reduction in number of erythrocytes.	
Hæmolysis . . . . .	Destruction of erythrocytes.	
Hæmoglobin . . . . .	Coloring matter of the blood.	
Oligochromæmia . . . . .	Reduction of hæmoglobin.	
Hæmoglobinæmia . . . . .	Presence of hæmoglobin in the serum.	
Hæmoglobinuria . . . . .	Presence of hæmoglobin in the urine.	
<b>LEUCOCYTES</b> . . . . .	White corpuseles.	
1. Lymphocytes . . . . .	Round mononuclear cells about the size of or small mononuclear erythrocytes, with faintly staining protoplasm. The nucleus stains deeply, and fills nearly the whole cell . . . . .	(Plate V., 1.)
(Young (unripe) elements of Uskow.)		
2. Large mononuclear . . . . .	Fully double the diameter of erythrocytes, with oval or round faintly-staining nucleus, filling a relatively small part of the cell . . . . .	(Plate V., 2.)
(Mature (ripe) elements of Uskow.)		



# PLATE V



Anaemia Infantum Pseudo-Leukaemia von JAKSCH.

Plasmodium Malariae  
Oil Immers. REICHERT  $\frac{1}{2}$   
Ocular N° 3.

LEITZ Oil Immers.  $\frac{1}{2}$  Ocular N° 3

- 1 Small Mononuclear (Lymphocytes)
- 2 Large Mononuclear
  - a Transitional
- 3 Polynuclear Neutrophils
- 4 Polynuclear Eosinophile
  - a Dwarf Eosinophilic Cell
- 5 Normal Red Corpuscles
- 6 Nucleated Red Corpuscles (Normoblast type)
  - a Megaloblast type
- 7a Poikilocytes
- b Microcytes
- 8a Large Mononuclear Neutrophils or Myelocytes
- b Large Mononuclear Eosinophiles



TABLE 84.—*Continued.*

3. Transitional forms . . . . .	Cells like the above, but having an indented (Lobulated or indented nucleus . . . . .) (Plate V., 2a.) forms of Uskow.)
4. Neutrophiles . . . . .	Considered by most observers the oldest or polynuclear cells variety of the leucocytes. The nucleus (more correctly polymorphnuclear. Old stains with basic stains; the plasma stains faintly with neutral aniline stains, and the granules stain with a combination of both (over-ripe) elements basic and acid stains, and hence are called of Uskow). <i>neutrophiles</i> . The nucleus is really polymorphous, though sometimes (apparently) broken . . . . . (Plate V., 3.)
5. Myelocytes . . . . .	Large, round, or ovoid cells, with one (seldom or large mononuclear two) large faintly-staining nuclei. The neutrophiles. "Mark-plasma is filled with small granules that zellen" of the Ger-take a neutral stain . . . . . (Plate V., 8a.) mans.
6. Eosinophiles . . . . .	Characterized by the presence of large, round, highly refractile granules, which stain with all acid coloring matters . . . . . (Plate V., 4.)
(a) Polymorphnuclear . . . . .	(Plate V., 4.)
(b) Mononuclear . . . . .	(Plate V., 8b.)
Leucocytosis . . . . .	An increase in the number of leucocytes, the increase being in the polymorphnuclear neutrophiles.
Microcytosis . . . . .	An increase in the number of microcytes.
Monochromatophilic . . . . .	Taking only one stain.
Polychromatophilic . . . . .	Taking more than one stain.
Basophilic . . . . .	Stained by basic stains.
Acidophilic . . . . .	Stained by acid stains.
or Eosinophilic.	
Neutrophilic . . . . .	Stained by neutral stains.
Amphophilic . . . . .	Stained by both basic and acid stains.
Erythroblasts . . . . .	A term used by some authors to describe certain very early stages in the development of erythrocytes found only in the blood-forming organs.
Leukoblasts . . . . .	A similar term applied to the early stages in the development of leucocytes.
Mitosis . . . . .	A division of nucleus and cell in which the or Karyokinesis. division is preceded by certain definite (Indirect cell division.) changes in the arrangement of the morphological constituents of the nucleus and cell.
Amitosis . . . . .	A simple division of nucleus and cell, not (Direct cell division.) accompanied by previous alteration in the constituents of either.

**BLOOD-KEY.**—I should like you to examine these colored pictures (Plate V., facing page 330), which represent all the principal normal and abnormal conditions of the blood in early life. They are, in fact, a key which Dr. Wentworth has so arranged that, by first becoming familiar



with the pictures in the plate, and then calculating the percentages from your microscopie blood-slides, you will be able to read and understand the special case which you are studying. Thus, knowing the special combination of the blood-elements which constitute a certain disease, and seeing that combination under your microscope, you can easily make the diagnosis of the disease.

This method is, of course, more satisfactory than showing the blood-field of any single case; for what we see is of no particular value until a histological computation of the relative percentages of the different elements composing the blood has determined the especial combination which represents the particular disease.

I shall now briefly describe to you the general methods by which blood-counts are made. For the special technique I must refer you to the admirable laboratory courses that are given in another department of the school.

The instrument used for estimating the number of red and white corpuscles is called the Thoma-Zeiss. It consists of two parts, a glass counting-slide and a mixing-pipette. By pricking the lobule of a carefully washed ear a single drop of blood is made to exude. The first drop of blood that comes having been wiped away and a second having taken its place, the end of the mixing-pipette is brought in contact with it and a portion is sucked up in the capillary tube, the amount taken being shown on a scale. The end of the pipette is then immersed in a diluting fluid, and the blood, with either one hundred or two hundred times its volume of the diluent, is sucked into the bulb to which the capillary tube enlarges. After this the pipette is shaken for at least two minutes to insure the even distribution of the corpuscles. For counting the erythrocytes the best diluting solution is that known as Toison's, the formula for which is,—

PREScription 40.

R Sulphate of sodium . . . . .	8.000
Chloride of sodium . . . . .	1.000
Glycerin . . . . .	30.000
Methyl violet . . . . .	0.025
Distilled water . . . . .	160.000

Having blown out the first few drops from the pipette, in order to be sure of getting a drop that represents a fair average, the next is put in the small depression that is made for it in the counting-slide. Around this central well is an overflow moat, bounded by a slightly raised glass plate. The whole is so constructed that, when the central well is evenly full of fluid and sealed over by laying on the cover-glass, its depth is exactly one-tenth of a millimetre. On the floor of this well a square millimetre has been ruled off into four hundred small squares. The drop of blood, just large enough to fill this well, but not to overflow the moat, shut in by its cover-glass, is laid aside for two or three minutes, so that the globules

may all fall to the bottom. Then, under the microscope, the number of red and white corpuscles lying in a definite number of the small squares can readily be counted, and, as each square is just one four-thousandth of a cubic millimetre, a very simple multiplication will give us the number of corpuscles in a cubic millimetre of the undiluted blood. All blood examinations are reported in terms of cubic millimetres. In my cases, one hundred and sixty small squares were counted in each of four successive drops of blood, and the average made up from these.

Although, owing to the blue color given them by the Toison's solution, the leucocytes can be counted at the same time as the erythrocytes, yet it is often more convenient to use a solution that, by rendering the red cells invisible and emphasizing the nuclei of the whites, will render the task of counting the relatively small proportion of white cells easier. For my counts a three-tenths of one per cent. solution of acetic acid was used, the blood diluted one hundred times, and twenty thousand squares counted.

The hæmoglobin percentage is generally determined by means of the Fleischl hæmoglobinometer. A fine piece of glass tubing set at right angles in a handle is used as the measure for the blood, which is then dissolved out in distilled water held in a glass-bottomed cell. The colored water is compared by artificial light with a graduated red glass prism, and when the exact equivalent is found an index on the instrument shows the percentage of hæmoglobin.

The third step in the process is the making of the dried cover-glass preparations. This is the one that can be most readily done by the general practitioner, and the one that will give him the most information. The cover-glasses must first be carefully cleansed with acid and alcohol. One of the clean cover-glasses is taken in the forceps and gently touched for a moment to a fresh drop of blood as it rests upon the ear; the second glass is then dropped upon the first. If both were perfectly clean, the blood will be seen immediately to spread itself out between the two as a delicate film. The glasses are at once separated by a sliding motion, and allowed to dry in the air. When dry, if protected from dust and moisture, they can be kept indefinitely. The next step in the process is to harden them. This may be done by soaking them in benzine for ten minutes, or in equal parts of ether and absolute alcohol for half an hour; or they may be heated, preferably by leaving them for two hours on a metal plate kept just hot enough to vaporize a drop of water, but for rough clinical work holding them in the fingers for a couple of minutes over the flame of an alcohol lamp is sufficient.

The last step in the process is the staining. To accomplish this a great variety of stains have been used, each bringing out some one peculiarity of cell-structure with greater distinctness than the others. The cells shown in the colored plate (Plate V., facing page 330) were stained with the Ehrlich triple stain, which is made as follows:



## PRESCRIPTION 41.

R Saturated watery solution of orange G . . . . .	125 c.c.
Saturated watery solution of acid fuchsine (containing 20 per cent. alcohol) . . . . .	125 c.c.
To this are added slowly, while constantly shaking the mixture, a	
Saturated watery solution of methyl green . . . . .	125 c.c.
Absolute alcohol . . . . .	75 c.c.

This stains the nuclei of the leucocytes a blue or bluish-green color, the neutrophilic granules a purple, and the eosinophilic granules a reddish tinge. The erythrocytes are stained a faint yellow. According to the amount of heating the cover-glasses have had, they are left in the staining fluid from one to four minutes, and then washed in plain water and dried. Finally, mounted in cedar oil or Canada balsam, they are ready for examination with the oil-immersion objective.

Of these various procedures the estimation of the hæmoglobin percentage must be done at once. The mixing-pipette, having been filled and shaken, can safely be left from twelve to fourteen hours or even longer without any change taking place in the corpuscles that will interfere with their being counted. The cover-glass films can, as I have already told you, be kept indefinitely.

**CHEMISTRY.**—The chemistry of the blood in early life has not yet been fully investigated. It may, however, be of interest to you to have a general idea of this fluid medium which we are about to study in health and in disease as it exists in the adult. In this way you will be better prepared to understand the more intricate pathological questions which must be dealt with later. This general idea can best be acquired by directing our attention to the chemistry of the blood.

The chief chemical facts which are known concerning the blood have been so lucidly stated by Foster that I can best assist you by quoting from what he says on the subject. Foster states that the average specific gravity of human blood is 1055, varying from 1045 to 1075 within the limits of health. The reaction of the blood as it flows from the blood-vessels is found to be distinctly, though feebly, alkaline. If a drop be placed on a piece of faintly red highly glazed litmus paper and then wiped off, a blue stain will be left.

The whole blood contains a certain quantity of gases, such as oxygen, carbonic acid, and nitrogen, which are held in the blood in a peculiar way, and which vary in venous and in arterial blood, and so serve especially to distinguish them from each other. These may be given off from the blood when exposed to an atmosphere, according to the composition of that atmosphere.

The normal blood consists of corpuscles and plasma. If the corpuscles be supposed to retain the amount of water proper to them, blood may, in general terms, be considered as consisting by weight of from one-third to somewhat less than one-half of corpuscles, the rest being plasma. The plasma is resolved by the clotting of the blood into serum and fibrin.



The serum contains, in 100 parts,—

Proteid substances . . . . .	about 8 or 9 parts.
Fats, various extractives, and saline matters . . . . .	about 1 or 2 parts.
Water . . . . .	about 90 parts.

The proteids are paraglobulin and serum-albumin in varying proportions, there being probably more than one kind of serum-albumin. We may perhaps say that they occur in about equal quantities.

The fats, which are scanty, except after a meal or in certain pathological conditions, consist of the neutral fats, stearin, palmitin, and olein, with a certain quantity of their respective alkaline soaps. The complex fat lecithin occurs only in very small quantities. The amount present of the peculiar alcohol cholesterin, which has so fatty an appearance, is also small. Among the extractives present in serum may be put down nearly all the nitrogenous and other substances which form the extractives of the body and of food, such as urea, kreatin, sugar, and lactic acid. A very large number of these have been discovered in the blood under various circumstances, the consideration of which must be left for the present. The odor of blood or of serum is probably due to the presence of volatile bodies of the fatty acid series. The faint yellow color of serum is due to a special yellow pigment. The most characteristic and important chemical feature of the saline constitution of the serum is the predominance, at least in man and in most animals, of sodium salts over those of potassium. In this respect the serum offers a marked contrast to the corpuscles. Less marked, but still striking, are the abundance of chlorides and the poverty of phosphates in the serum as compared with the corpuscles. The salts may, in fact, briefly be described as consisting chiefly of sodium chloride, with some amount of sodium carbonate—or, more correctly, sodium bicarbonate—and potassium chloride, with small quantities of sodium sulphate, sodium phosphate, calcium phosphate, and magnesium phosphate. Of even the small quantities of phosphates found in the ash, part of the phosphorus exists in the serum itself, not as a phosphate, but as phosphorus in some organic body.

The red corpuscles contain less water than the serum, the amount of solid matter being variously estimated at from 30 to 40 per cent. or more. The solids are almost entirely organic matter, the inorganic salts amounting to less than 1 per cent.

The red coloring matter which in normal conditions is associated with this stroma may by appropriate means be isolated, and in the case of the blood of many animals obtained in a crystalline form. It is called *hæmoglobin*, and may by proper methods be split up into a proteid belonging to the globulin group, and into a colored pigment, containing iron, called *hæmatin*. Hæmoglobin is therefore a very complex body. It is found to have remarkable relations to oxygen, and indeed the red corpuscles by virtue of their hæmoglobin have a special work in respiration, for they carry oxygen from the lungs to the several tissues.

Of the organic matter, again, by far the larger part consists of hæmoglobin. In 100 parts of the dried organic matter of the corpuscles of human blood about 90 parts are hæmoglobin, about 8 parts are proteid substances, and about 2 parts are other substances. Of these other substances one of the most important, forming about a quarter of them and apparently being always present, is lecithin. Cholesterin appears also to be normally present. The proteid substances which form the stroma of the red corpuscles appear to belong chiefly to the globulin family. As regards the inorganic constituents, the corpuscles are distinguished by the relative abundance of the salts of potassium and of phosphates. This at least is the case in man. The relative quantities of sodium and potassium in the corpuscles and serum respectively appear, however, to vary in different animals; in some the sodium salts are in excess, even in the corpuscles.

The proteid matrix of the white corpuscles is composed of myosin, or an allied body, paraglobulin, and possibly other proteids. The nuclei contain nuclein. The white corpuscles are found to contain, in addition to proteid material, lecithin and other fats, glycogen, extractives, and inorganic salts, there being in the ash, as in that of the red corpuscles, a preponderance of potassium salts and of phosphates.

The main facts of interest, then, in the chemical composition of the blood are as follows. The red corpuscles consist chiefly of hæmoglobin. The organic solids of the serum consist partly of serum-albumin and partly of paraglobulin. The serum or plasma contrasts in man, at least, with the corpuscles, inasmuch as the former contains chiefly chlorides and sodium salts, while the latter are richer in phosphates and potassium salts. The extractives of the blood are remarkable rather for their number and variability than for their abundance, the most constant and important being perhaps urea, kreatin, sugar, and lactic acid.

**ORIGIN.**—According to Ziegler, the regeneration of the colorless blood-corpuscles takes place principally in the lymphadenoid tissues of the lymph-glands, the spleen, and the intestinal tract. The lymph-bulbs contain regions, sharply differentiated from the surrounding tissue, in which are always to be found stellate figures which for the most part belong to free cells. These regions are called by Flemming "germ-centres." In addition to this, a division of leucocytes takes place in the lymph-channels of the lymph-glands and other tissues, and there can be little doubt that leucocytes also divide while circulating in the blood or wandering among the tissue-clefts.

This division may be either by mitosis, which gives cells with peculiarly lobate or crown-like nuclei, or by amitosis, in which case the nucleus appears broken into fragments.

The mitotic division is that which leads to the formation of vigorous cells. To what extent the amitotic division—that is, the breaking down of the nucleus—is also followed by cell division is difficult to determine, but it is probably true that this represents the result of a process of destruction,



and that the change from mononuclear to polynuclear cells should therefore be looked upon as a degeneration. Frequently under pathological conditions there occurs an increase in leucocyte-formation.

Since in leucæmia the spleen, the lymph-glands, or the bone-marrow show a hypertrophic condition with increased cell-production, it may be supposed that they furnish the increase of leucocytes to the blood. The regeneration of the red blood-corpuscles occurs probably by mitotic division of the red nucleated young forms. In adults this division takes place only in the bone-marrow, which is true also of mammals, birds, reptiles, and the tailless amphibiæ; in the tailed amphibiæ and in fishes it can occur in the spleen as well. In the embryo this process can go on in the entire vascular system. Later it becomes concentrated in the liver, spleen, and bone-marrow, and finally becomes restricted, according to our present knowledge, to the marrow alone. Where these nucleated young forms originate is still a matter of dispute, some investigators considering that they are the direct descendants of the young forms of embryonic life and that they have always held hæmoglobin, others maintaining that they are developed from pre-existing nucleated forms without hæmoglobin, which in their turn are said by some to multiply in the vessels of the marrow, and by others to originate also in the spleen.

Neumann believes that there either occurs a development of the nucleated blood-corpuscles out of the leucocytes of the blood which after birth are conveyed through the arteries to the bone-marrow, or that they spring from the tissue elements of the bone-marrow.

**FATE OF THE RED CORPUSCLES.**—About the length of life and the ultimate fate of the red corpuscles little is known. Osler points out that the bile coloring matters and certain of the urinary pigments have their origin in altered hæmoglobin, which would require the daily destruction of many red blood-corpuscles. So far as we can see, these corpuscles are removed without undergoing much alteration. Certain evidence, however, seems to point to the spleen and liver as organs in which they are broken up, and in which they are perhaps used again in making the new corpuscles.

**FÆTAL BLOOD.**—In accordance with the fact that the younger the individual the more unformed, or rather unripe and undeveloped, are the elements of the blood, certain stages of the corpuscular development being transmitted directly from the fœtal conditions, it will be wise to speak first of the character of the blood in intra-uterine life. Taking these conditions as a starting-point and using the adult blood for comparison, we can obtain a fairly comprehensive understanding of the various conditions which are known to be present in the blood of infants and children.

According to Scherenziss, the specific gravity of the fœtal blood at the moment of birth is somewhat lower than that of the adult's. That of the serum is markedly lower. The red corpuscles are poor in hæmoglobin and rich in stroma. Compared with the adult, the hæmoglobin is as 76.8 to 100.



The amount of fibrinogen is relatively small, and as compared with the mother's blood is as 2 to 7.

Fœtal blood is not well qualified for the method of quantitative analysis by means of washing with salt solution, because many of the elements which are loosely held in the red corpuscles, especially the hæmoglobin, are easily washed out.

The fœtal blood is somewhat richer in sodium and considerably poorer in potassium than is adult blood. The amount of chlorine not combined with sodium and potassium is much less than in adult blood. The sex and weight of the child at the moment of birth do not appear to have any influence upon the quantitative composition of the blood.

Some authors have thought that they found a lessened tendency to coagulation in the blood of the new-born. Krüger found that this tendency existed in the sense that the coagulation occurred slowly. He thought that this was due to the diminished tendency of the leucocytes to undergo retrograde changes. He also found more iron in the blood at birth than after a lapse of fourteen days.

**ERYTHROCYTES.**—Normally, the red corpuscles in the fœtal blood are nucleated, at least in the early months; they are of the normoblast type (Plate V., 6, facing page 330). After the seventh month they diminish rapidly in number, and give place to the normal red corpuscle. There is some difference of opinion as to the frequency of the occurrence of the normoblasts in the last few months of intra-uterine life, but the best observers seem to agree that they are rather infrequent.

**LEUCOCYTES.**—Fischl, in a report of four cases, found up to the end of the seventh month very few eosinophiles, after this a large number, and then a diminution towards the end of full term; and the observations of Weiss agree with this. He found little variation in form and in size. There is a low percentage of lymphocytes up to the seventh month, the majority of the corpuscles consisting of the large mononuclear cells (Plate V., 2). After the seventh month, an increase of the former and a diminution of the latter occur as full term is approached. The transitional variety (Plate V., 2a) predominates at birth, and later gives place to the polynuclear (Plate V., 3 and 4, facing page 330).

Gundobin found that in the blood of premature infants the lymphocytes (Plate V., 1) were both relatively and absolutely increased, and that it was therefore a younger blood. He found also that the same changes occur in the leucocytes of the premature infant's blood as in that of the infant at full term, only that there is a more rapid diminution up to the third or fourth day, and that the leucocytes remain below the average a longer time, from ten days to three weeks, than they do in the blood at full term. When the development of the infant was slow, its blood was correspondingly slow in development, its red corpuscles were diminished, its hæmoglobin was diminished, there was an increase of leucocytes, and in this way a condition of anæmia with leucocytosis was produced.

Just as I have explained to you that to understand intelligently the diseased conditions of early life you must first acquire a knowledge of the normal development of the infant and child during the different periods of their existence, so I wish to impress upon you the importance of knowing what exists normally in the blood of early life before you can appreciate the abnormal conditions. I shall therefore first describe what is found in the normal infant's and child's blood, comparing it with the adult's blood, and then point out the variations caused by disease.

**NORMAL BLOOD AT BIRTH.**—**AMOUNT.**—Welcker states that the total amount of blood at birth is one-nineteenth of the body-weight. His opinion is based on the examination of a poorly developed infant, in which the umbilical cord was ligatured immediately at birth.

Schuecking places the amount at one-fifteenth of the body-weight, from an examination of five full-term infants, without expressing the blood from the placenta, and with immediate ligature of the cord. When the cord was tied later, and the so-called "reserve" blood was expressed from the placenta, the percentage rose to one-ninth. In adults the relation of the blood to the body-weight is stated to be one-thirteenth. All authors agree that there is a temporary gain in the amount of the blood when the cord is tied late.

**REACTION.**—The reaction of the blood at birth is always alkaline.

**COLOR.**—The color is found to be darker in the capillaries during the first few days than at any other time.

**SPECIFIC GRAVITY.**—At birth the specific gravity of the blood is about 1065, and this does not vary for the first few weeks. From this time up to the second year there is a constant diminution, decreasing in boys to as low as 1048 and in girls to 1050. It then gradually rises, till at the end of the first year it has reached the normal average of 1050 to 1058. The specific gravity seems to be uninfluenced by the number of red or white corpuscles, food, rest, exercise, or other causes, but depends directly upon the amount of hæmoglobin. As a whole, the specific gravity is, apart from physiological variations, very constant in the same individual, and remains for weeks and months the same. Hock and Schlesinger place the greatest twenty-four-hour variation at 0.00025. Let me here remind you that the appearance of the child's skin is not an index to the specific gravity of the blood or to the amount of the hæmoglobin. Children often appear anæmic without any especial alteration in either of these conditions.

**Specific Gravity of the Blood-Serum.**—Hock and Schlesinger's results are the most reliable. They estimated the specific gravity by a method of Hammerschlag's which has not yet been published. They found in young children that the physiological variations were much greater than in adults, and were often between 1026 and 1031. Adults, on the other hand, according to Hammerschlag, showed very little variation, perhaps from 1029 to 1031. Older children resemble adults. The deductions from these investigations seem to be, that any marked change in the specific



gravity either of the blood or of the serum, aside from the action of drugs on the hæmoglobin, denotes a marked change in the whole organism and in the functions of the various organs.

**HÆMOGLOBIN.**—The hæmoglobin is found to be less firmly bound to the red corpuscle in the infant at term than it is in adults. It is, however, proportionately greater at birth than in adult life. The hæmoglobin, like the specific gravity, which, as I have told you, seems to be dependent upon it, reaches its maximum at birth. Starting at 100 or 104, it falls rapidly to its minimum in the first three weeks of life. (Hock, Schlesinger, Widowitz, Schmaltz, and Hammerschlag.) The lowest percentage that you will find varies from 55 to 96.5 per cent. From two weeks to six months it remains about the same, and then rises slowly.

**ERYTHROCYTES** (Plate V., 5, facing page 330).—So far we have been studying the blood as a whole. I shall now direct your attention to its more minute composition. Here, under the microscope, is a specimen showing the normal red corpuscles, as seen through a Leitz oil-immersion  $\frac{1}{12}$  and an ocular No. 3.

All authors agree that there is a large number of these erythrocytes at birth, and also that an increase occurs in the first twenty-four hours. As regards the actual number in a cubic millimetre of blood there is much diversity of opinion. From the second day the erythrocytes begin normally to diminish, and fall eventually, according to Lépine, Gerard, and Schlemmer, to 5,000,000. These authors found the loss of body-weight during the first twenty-four hours to be accompanied by an increase of the red corpuscles. Lépine attributed the variations to changes in the blood-plasma, and not to a new formation or to a degeneration of the corpuscles.

Hayem always found a larger number at the moment of birth than in the mother's blood, and gives as an average 5,350,000. He states that tying the cord influenced the number, the average being perhaps half a million higher when the cord was tied late. This effect is temporary, however, as is shown by Schiff's experiments. When the infant's weight was lowest, Hayem found that the count reached its maximum. From this time a slow but constant diminution took place, and in the second week it was found to be about half a million less than at birth. He thought that the increase was due not alone to the loss of fluid, but also to the increased formation, because in maximal counts he found the corpuscles smaller, and considered them, therefore, younger.

Stierlin examined older children, and found the erythrocytes to be very similar to those found in adults. There appeared to be more red corpuscles in each cubic millimetre of the blood of boys than in that of girls, about 350,000 more.

Schiff seems to have done the most thorough work on the estimation of the erythrocytes. He calculated the total blood quantity as well as he was able, and based his results on this. He found the highest count on the first day of life, and a diminution in the next few days, with hourly variations;



but each succeeding day the count was lower. This shows the value of conducting experiments on the blood at the same hour of the day. The increase after birth is only seeming, according to Schiff, and is due to a loss of fluid and consequent concentration of the blood, because after the first feeding the counts are lower. He agrees with Lépine, except that he thinks the changes in the blood are not due to gain or loss in weight, but to the fluid taken into the system, and he showed that in a fasting infant, after several hours, there was an increase in the red corpuscles. Schiff places the average at birth at 5,800,000, and is unable to observe any influence of sex at this age.

LEUCOCYTES.—The white corpuscles are more numerous at birth than in adults or in young children. As I have already stated regarding the red corpuscles, the counts of the white corpuscles vary according to the examiner; so that our knowledge of the exact figures which should represent these counts is by no means settled.

Schiff found the highest counts, in the first twenty-four hours following the first feeding, to be from 26,000 to 36,000 in a cubic millimetre. He never found the rapid diminution noted by Hayem at the end of a physiological loss of weight, nor did he find so low a count as 4000 to 6000 at this time. He called attention to the daily variation in consequence of digestion, which is of the utmost importance to bear in mind when examining pathological blood. He estimated that from the twelfth to the eighteenth day the average figures were from 12,000 to 13,000, and for older children 10,000.

Hayem found that in the first few days of life there were three or four times more leucocytes than in adult blood, and his estimated average was 18,000. His average of 5000 for adult blood is rather low. He found that this average of 18,000 persisted until the physiological loss of weight had ended, when it was rapidly reduced to from 14,000 to 12,000. At the time when the infant begins to gain in weight the count rises to from 19,000 to 23,000, and there remains constant for a few days. The daily variations in the early days of life are more marked than in adults.

Gundobin, in an examination of infants from ten days to a year old, found an average of 12,900, the variations being from 10,000 to 14,000. The adult variation he estimates to be from 7000 to 10,000.

Bouchut and Dubrisay found the average of a number of counts in children from two to fifteen years of age to be 6700.

Denis examined the blood of artificially fed and breast-fed infants. He found the diminution of the leucocytes occurring on the fourth day, and that it took place more rapidly in the breast-fed than in the artificially fed. He observed that the counts in infants were higher than in adults, and that an increase of the white corpuscles occurred in poorly nourished infants. He refers to the influence of food on the counts, and states that soon after feeding an increase in the leucocytes was observed.

Anna Bayer, a pupil of Denis, estimates the leucocytes of new-born

infants and young children as between 16,000 and 23,000. In later childhood, up to the sixth year, she placed them at from 9000 to 10,000.

The cause of the leucocytosis of the new-born, according to Gundobin, is a predominance of the “over-ripe” elements (neutrophiles, Plate V., 3), these cells forming from 60 to 80 per cent. of the total increase. He thinks this is due to a diminished activity of the retrograde metamorphosis. From the second day the process is more rapid, and from the seventh day to the tenth day the white corpuseles have reached their normal condition, which is found to be due to an absolute and relative increase of lymphocytes,—that is, the blood becomes younger.

Gundobin opposes Lépine’s theory that the leucocytosis of the new-born infant is due to a concentration of the blood, and also Schiff’s theory that there is an increased flow of lymph from the tissues into the blood when the child is hungry.

A fair average of the leucoeytes in the blood of infants from six months to a year old is from 10,000 to 12,000. After the first two or three weeks, and up to six months, it is found to be from 12,000 to 14,000. Combining these observations as well as we can, I find the average figures regarding the number of the erythroeytes and leueocytes at different ages to be as I have represented in this table (Table 85). These figures assume a loss of weight for forty-eight hours and then a gradual gain.

TABLE 85. (R. C. Cabot.)

*Normal Average Number of Blood-Corpuscles at Different Ages in Cases where there was a Loss of Weight in the First Forty-Eight Hours.*

Age.	Erythrocytes.	Leucocytes.
At birth . . . . .	5,900,000	21,000 (26,000 to 36,000 after first feeding.)
End of 1st day . . . . .	7-8,800,000	24,000
“ 2d “ . . . . .	generally increased.	30,000
“ 4th “ . . . . .	6,000,000	20,000
“ 7th “ . . . . .	5,000,000	15,000
10th day . . . . .		10-14,000
12th to 18th day . . . . .		12,000
1st year . . . . .		10,000
6th year and upwards . . . . .		7,500

After a meal 30,000 leueocytes is never an abnormal count in infants under two years.

**Nucleated Red Corpuscles** (Plate V., 6, facing page 330).—Neumann and Kölliker found large numbers of nucleated red corpuscles at birth (erythroblasts of Ehrlich, the “eellules rouges” of the French). Hayem, Luzet, Loos, Fischl, and other authors did not find these numerous erythroblasts, and say that they are found in large numbers in foetal life only. The few which are found are usually of the normoblast type. After six months they are rarely or never found normally. They are considered to be the result of delayed function. Pathologically, their presenee may be of considerable



importance. Ehrlich divided them into three kinds, depending on their size and on the staining property of the nucleus: (1) the *normoblast*, which is the size of a normal red corpuscle, and has a small, deeply-stained nucleus; (2) the *gigantoblast* or *megaloblast*, which is very much larger, perhaps three or four times, than the red corpuscle, and has a large, pale, or fragmented nucleus; and (3) the *microblast* or *poikiloblast*, which is a very rare form, and corresponds to the microcyte in size. The normoblast is the type commonly found.

**LEUCOCYTES.**—Five varieties of white corpuscles are found normally in human blood, and they have been classified in various ways. Ehrlich's classification is as follows:

1. **Small Mononuclear, or Lymphocytes** (Plate V., 1, facing page 330).—These are small, round in shape, about the size of a red corpuscle, and contain a large round nucleus, which usually takes an intense stain with all basic stains. The protoplasm is a narrow band encircling the nucleus, and at times is so narrow as not to be visible. It sometimes stains faintly with eosin, and sometimes does not stain at all. These lymphocytes often vary much in size, and at times are so large as to be indistinguishable from the large mononuclear variety.

2. **Large Mononuclear** (Plate V., 2, facing page 330).—These cells are considerably larger than the lymphocytes, often two or three times. They have a large oval or ovoid nucleus, which stains faintly, and a large amount of almost colorless protoplasm surrounding the nucleus and giving the cell very much the appearance of a vacuole. The protoplasm stains very faintly with eosin.

3. **Transitional Forms** (Plate V., 2*a*, facing page 330).—Among the large mononuclear cells there is found at times a transitional variety. Similar in other respects to the large mononuclear corpuscles, they differ in that the nucleus is undergoing transition. This is shown by a more or less deep indentation, which gives to the nucleus a saddle-bag or horseshoe shape.

4. **Polynuclear, or more properly Polymorphnuclear, Neutrophiles** (Plate V., 3, facing page 330).—These corpuscles are somewhat smaller than the large mononuclear, more round in shape, and with a peculiar polymorphous deeply-staining nucleus. At times the nuclei resemble the letters S, V, Z, E. When stained the nucleus often appears segmented; hence the name "polynuclear." The protoplasm is acidophilic; that is, it has an affinity for acid stains, and is filled more or less completely with fine granules, which are not very refractive and are stained by neutral stains; hence the name "neutrophile." These corpuscles are more contractile than the other varieties, and are the ones most frequently found in pus, as they have the faculty of passing easily through the walls of the vessels by means of their mobility.

The last three named varieties are generally considered to be the same corpuscle undergoing metamorphosis, during which process the protoplasm becomes opaque and is changed from basophilie to acidophilie. The



opacity is due to the fine neutrophilic granules which have appeared in the protoplasm. This change is supposed to occur in the blood, and, according to Ehrlich, is due to some nutrient material present there. Possibly the corpuscles are better nourished in the blood than in the organs which are supposed to produce them.

The transitional conditions are supposed by Uskow to be either a degenerative or a ripening process, of which the lymphocytes represent the "young" or "unripe cell," the large mononuclear the "ripe" cell, and the polynuclear cells or neutrophiles the "old" or "over-ripe" cells.

5. **Myelocytes, or large Mononuclear Neutrophiles** (Plate V., 8a, facing page 330).—These are large round or ovoid neutrophilic cells which probably originate in the bone-marrow. They contain one, very seldom two, large round or slightly bent nuclei, which stain blue. The body of the cell, which forms a ring around the nucleus, is crowded with a quantity of fine neutrophilic granules. Myelocytes are rare in normal blood, but are much increased in some of the pathological states. (Klein.)

6. **Polynuclear Eosinophiles** (Plate V., 4, facing page 330).—These cells are generally about the size of neutrophiles, and have a nucleus, staining deeply, which is similar to that of the neutrophile in shape and in its apparent segmentation. The protoplasm is acidophilic, and is more or less completely filled with coarse generally round or ovoid highly refractive granules, which have an affinity for acid stains. The origin, significance, and composition of these cells have caused more discussion and research than those of any of the other varieties. Ehrlich states that the granules are not albuminoid, and concludes that their composition is of a complex nature. Weiss maintains that they are albuminoid, and bases his assertion on the results of micro-chemical experiments performed by himself and others. Ehrlich thought at one time that the only place of origin for these cells was the bone-marrow, and that their occurrence in the blood in large numbers signified chronic changes in the blood-making organs. Since then it has been satisfactorily demonstrated that they occur—pathologically, at any rate—in various secretions. Neusser found them in large numbers in the blood in certain skin affections. According to Canon, who verified this, the number was less dependent upon the disease itself than upon the amount of surface involved. They are frequent in the blood and bronchial secretion in asthma; also in the prostatic secretion under certain circumstances, and in the urine of septic nephritis. The number is normally very variable in the blood of infants and children, so that they have not the significance that they may have in the blood of adults. Weiss considers their increase as occurring entirely independently of the other leucocytes, and for this reason their comparative percentage has a doubtful value.

7. **Mononuclear Eosinophiles** (Plate V., 8b, facing page 330).—Very similar to the myelocytes are the so-called eosinophilic myelocytes. They differ from them in having in the cell protoplasm eosinophilic granules in place of neutrophilic granules.

**8. Broken Cells.**—In addition to the above-mentioned varieties, we find in some conditions of the blood polynuclear cells that have lost their regular outline and appear as though burst, with their granules scattered outside the cell-body. Their cause and significance are still matters of dispute.

**GRANULES.**—By reason of their affinity for certain staining reagents, Ehrlich was enabled to differentiate seven varieties of granules occurring in the cells of the blood, five of which occur in the human blood. The staining fluids are divided into acid, basic, and neutral stains. The latter are obtained by combining a basic with an acid stain in certain proportions.

This affinity for certain staining agents or groups of staining agents Ehrlich terms their *elective power*; the degree of intensity with which they stain he terms their *tinctorial power*. He considers that but one kind of granule ever occurs in the same cell, and then only in the protoplasm. He attributed the former of these phenomena to a specific secretory function of the protoplasm, and hence the term specific granulations which he applied to these granules. These granules differ in their reaction to staining fluids, in size, in shape, and in solubility. They are usually more or less round. Their size is about the same in each variety, but is markedly different in different varieties, the eosinophiles being the largest.

The lymph-glands do not produce any cells containing granules, and Ehrlich believes that each variety must have its own peculiar protoplasm. He looks upon the granules as the product of cell activity, which is sometimes a function of reserve material, and at other times is a process of elimination. He found their composition to be complex.

Ehrlich classified these five varieties of granules that are found in the white cells in human blood as follows:

1.  $\alpha$  Granules.—*Eosinophilic*.—Stained by all acid stains. They are neither fat nor albumin. (This has since been denied by Weiss.) These granules are coarse, round, and highly refractive. The leucocytes containing them are present normally in the blood in small numbers.

2.  $\beta$  Granules.—These are fine round granules stained by acid and basic stains (amphophilic), and occur in the medullary cavity of human bones, and in many of the leucocytes of rabbits and guinea-pigs.

3.  $\gamma$  Granules.—This variety is basophilic, and represents the German "mastzellen-körnung." They are moderately coarse, round, and not very refractive. They are said by Ehrlich not to occur normally in the blood. Other authors, however, have found them in small numbers. They are found in bone-marrow and connective tissue. They also occur pathologically in the blood of leucæmia in varying numbers, and occupy more or less of the protoplasm of the large mononuclear cells. They are thought by most investigators to be pathognomonic of leucæmia when found in large numbers.

4.  $\delta$  Granules.—These are basophilic, and are found in the mononuclear elements of human blood. The difference between this variety and



the "mastzellen" granules, both of which are basophilic, has not yet been described by Ehrlich.

5.  $\epsilon$  Granules.—*Neutrophiles*.—These granules are stained by neutral stains, are very fine, are not refractive, and usually fill the protoplasm more or less completely of the polynuclear leucocytes with the exception of the eosinophiles. The nature of these granules is not known. This affinity for staining reagents is more than superficial, as a chemical reaction is supposed to occur. Weiss doubts whether the granules in the cells are the result of a specific cell function. The living cell is a very complex substance, with varied properties, morphological and chemical, and the granules may be formed in a number of ways and from chemically different substances to serve various purposes.

**Percentages of Various Leucocytes in Normal Blood.**—Estimates have been made by many observers of the percentages of the different leucocytes in normal blood. It is sufficient to note that the blood of infants differs from that of adults in that the blood of the latter contains from 60 to 75 per cent. of neutrophiles, the remaining 40 to 25 per cent. being made up of mononuclear cells, of which about 28 per cent. are lymphocytes; while in the infant the mononuclear cells, which include the lymphocytes and the large mononuclear cells, form the majority of the cells, perhaps two-thirds or three-quarters, and in very young infants the percentage is even higher. The following table (Table 86) illustrates what I have just said:

TABLE 86.

	Adults.	Infants.
Small mononuclear . . . . .	24 to 30 per cent.	50 to 70 per cent.
Large mononuclear . . . . .	3 to 6 "	6 to 14 "
Neutrophiles . . . . .	60 to 75 "	28 to 40 "
Eosinophiles . . . . .	1 to 2 "	$\frac{1}{2}$ to 10 "

Gundobin finds very little change from the above figures until the beginning of the third year, when the blood resembles more that of adults, the neutrophiles and mononuclear elements being present in about equal proportions. In children of eight or ten years he found very little difference from the blood of adults.

His conclusions are that infants' blood is (1) richer in white corpuscles; (2) richer in young form elements, the absolute and relative counts of the lymphocytes being three times as large as in the blood of adults, while the "over-ripe" elements, or neutrophiles, are half as many; (3) in infants the white corpuscles remain relatively longer in the "unripe" and in adults in the "over-ripe" stage.

Experiments have also been made to determine the constancy of the absolute number of white corpuscles and their relative percentages in healthy infants under different conditions. It is found that the longer the interval between the feedings the more marked is the increase in the white corpuscles during digestion. After two or three hours' fasting there is not much



change in the blood ; after five hours' interval there is always a leucocytosis averaging from two to four thousand. The cause is to be found in an absolute and relative increase of neutrophiles, the number of which corresponds to the increase. Morphologically, therefore, the blood is older.

The time of day, variations in temperature, and physical exertion seem to have no effect upon the number of the white corpuscles. Most authors place the normal percentage of eosinophiles between 2 and 10 per cent. It is safe to say that they may be somewhat increased, even considerably, in infants' blood without having the same significance as in adults' blood.

It may be of value to speak of certain sources of error in computing percentages which Weiss mentioned,—namely, that it is not enough to count the varieties of corpuscles of each kind, and thus estimate the percentage of each, because you are then dealing with comparative and not absolute figures. It will readily be seen that if a leucocytosis is present, and one variety of corpuscle is increased, it must make the others appear relatively diminished, whereas they may be absolutely normal or even increased. The following table of Weiss shows this plainly :

TABLE 87.

Counts.	Eosinophiles.	Total Leucocytes.	Percentages.
1 . . . . .	300	10,000	3+
2 . . . . .	300	20,000	1.5+
3 . . . . .	600	40,000	1.5+
4 . . . . .	600	10,000	6+

This table shows how little reliance can be placed on a comparative count in a given case, for the percentages show a marked variation without being any index as to whether an actual change in the number of eosinophiles has occurred or not. In the first count they are normal ; in the second they are absolutely normal and relatively diminished ; in the third they are absolutely increased and relatively diminished ; and in the fourth they are absolutely and relatively increased. This explains to some extent the contradictory percentages which have been reported. In order, therefore, to estimate an absolute increase of any variety a possibly concurrent leucocytosis must be taken into account. Another source of error mentioned by the same author lies in the staining fluid. Where acid and alkaline solutions are combined for staining purposes, it is possible, accidentally, for the alkaline solution to be so strong that not only do the coarse granules stain, but also the fine neutrophiles. Both have a red color, and a person depending on the color alone might mistake the neutrophiles for eosinophiles. The size and refraction of the granules should therefore be observed in every case.

## LECTURE XV.

## THE PATHOLOGY OF THE BLOOD IN EARLY LIFE.

PREMATURE INFANTS—NEW-BORN—LEUCOCYTOSIS—LEUCÆMIA—OLIGOCYTHÆMIA—PRIMARY ANÆMIAS—CHLOROSIS—ANÆMIA PROGRESSIVA PERNICIOSA—ANÆMIA INFANTUM PSEUDO-LEUKÆMICA VON JAKSCH—SECONDARY ANÆMIAS—TREATMENT OF DISEASES OF THE BLOOD—CONGENITAL SYPHILIS—RHACHITIS.

FROM what I have in the previous lecture described to you concerning the elements of the normal blood, you will now be able to appreciate the conditions which occur in various diseases. So far as our present knowledge of the blood in early life goes, its general diseases may be disposed of quite briefly, only a few characteristic conditions from a diagnostic standpoint having as yet been discovered. Traces, however, of diseases which have caused changes in the blood are often observed for a long time, and may afford an estimate of the patient's condition. For instance, the hæmoglobin is often comparatively low after the red corpuscles have reached their normal number, and thus affords an index to the rate of improvement.

As I shall frequently refer to the expert work which has been done by Dr. Richard C. Cabot on this subject, I wish to acknowledge my appreciation of the careful manner in which he has verified my cases.

I also wish to speak of the great assistance which I have received from Dr. John Dane, through his laborious work on and masterly grasp of this special branch of diagnostic medicine.

**PREMATURE INFANTS.**—You may remember that in my lecture on Development I explained to you that premature infantile conditions are in one sense—namely, the developmental—closely allied to the pathological. It therefore seems proper to speak of the premature infant's blood before considering the abnormal conditions of the blood in early life.

Here in Ward R is an infant (Case 104) premature at about the eighth month.

## BLOOD EXAMINATION 1. (Whitney and Wentworth.)

*Premature Infant, 8 months, thriving.*

	Feb. 6.	Feb. 9.	Feb. 15.	Feb. 27.
Erythrocytes . . . . .	5 118,750	5,023,750	5,072,500	4,500,000
(a few nucleated.)				
Hæmoglobin . . . . .	101 per cent.	98 per cent.	101 per cent.	91 per cent.
Leucocytes . . . . .	16,500	15,500	24,000	18,000
Small mononuclear . . . . .	19 per cent.	47 per cent.	61 per cent.	39 per cent.
Large " . . . . .	7 "	33 "	19 "	32 "
Polynuclear . . . . .	74 "	15 "	20 "	19 "
Eosinophiles . . . . .	0	5 "	?	10 "

You will notice the high relative percentage of the lymphocytes, which you would expect in the early days of life. The percentage of polynuclear cells was extraordinary on February 6, especially when compared with the count three days later. For an infant, this was a very marked neutrophilic leucocytosis, for which no cause could be ascertained.

**THE NEW-BORN.**—Gundobin thinks that it is proper to speak of the new-born infant's blood as pathological. He considers that the morphological changes which occur in the blood during the first few days of life are not accounted for by the ordinary physiological conditions; that the variations in the weight of the new-born and the quantitative and qualitative changes in the form-elements of the blood correspond, so far as they are caused by the same processes; that the probable cause of the morphological and the chemical differences between the new-born infant's blood and that of the nursing infant is to be found in the deviation from a normal tissue metamorphosis occurring in the new-born; finally, that the organism of the new-born infant shows very little power of resistance to pathological processes, and that the examination of the blood after Ehrlich's method shows better the length of the period of development usually designated by the term "new-born" than any other means.

I have here another infant (Case 114), fourteen months old, to show you.

It is apparently perfectly healthy, but a physical examination shows that its growth has been retarded, and that it really only represents the development of an infant about seven months old, so far as its weight, teeth, and functions are concerned. The blood examination presents characteristics which correspond to the stage of its development rather than to its age. Its blood therefore can be considered abnormal, but illustrative of an early stage of development.

BLOOD EXAMINATION 2. (Whitney and Wentworth.)

*Infant 14 months. Development corresponds to 7 months.*

Erythrocytes . . . . .	4,928,750
Hæmoglobin . . . . .	45 per cent.
Leucocytes . . . . .	23,000
Small mononuclear . . . . .	66 per cent.
Large " . . . . .	17 "
Polynuclear . . . . .	16 "
Eosinophiles . . . . .	1 "

With a few exceptions, such as malaria, leucæmia, chlorosis, anæmia progressiva perniciosa, and anæmia infantum pseudo-leukæmica von Jakseh, it is hardly wise at present to attempt to classify changes in the elements of the blood, according to their origin, into primary and secondary diseases. I shall therefore merely explain to you exactly what was found in my examinations of the blood in various diseases, with the hope that this work may aid you in understanding the far more extensive investigations which are being made in Europe.

There are certain changes in the blood which occur under varying conditions, both physiological and pathological. They are quite commonly met,



and are found in many different diseases, whether the diseases are primary in the blood itself or are merely represented secondarily by the changes in the blood. These general changes may be divided into two broad classes, (1) leucocytosis and (2) oligocythæmia, and I think that you will better understand what I shall say concerning the blood in each disease if I first describe these general classes, with, so far as is possible, the especial diseases which belong to them.

**LEUCOCYTOSIS.**—The best definition of leucocytosis that I can give you is one that has been formulated by Dr. Richard C. Cabot. He says that “leucocytosis is the presence in the blood of an increased number of white cells of the same varieties morphologically as those in normal blood, a plurality, and generally an overwhelming plurality, being polynuclear.” Physiologically, we find a leucocytosis after the ingestion of any proteid food. It is at its height about two hours after a meal, when the total number of leucocytes may be as great as from 13,000 to 30,000, according to the age of the child. Pathologically, a leucocytosis follows a considerable number of diseases, and seems in a general way to depend upon the amount of local reaction to which the disease gives rise. We find a pronounced leucocytosis in most fevers and in most septic processes. Von Limbeck, in his article on inflammatory leucocytosis, says that a leucocytosis not only accompanies an exudation, but “corresponds in degree to the number of cells in the exudation; that is, whether it is serous or purulent.” Of the pyogenic bacteria he says that the staphylococcus seemed most productive of leucocytosis, especially the pyogenes aureus. It is not known why this should be so. In these cases the increase is almost wholly composed of the polynuclear neutrophiles, which may make up from 90 to 98 per cent. of the entire leucocyte count.

Although I shall have occasion, in showing you cases in the wards, to speak in detail of many of the diseases that give rise to a leucocytosis, I will now briefly enumerate them. Pneumonia shows generally a leucocytosis, and especially if the case is to have a favorable termination. In pneumonia the large increase in the number of leucocytes seems to follow closely the course of the pathological process, and the “blood crisis” is found to anticipate the “temperature crisis” by some hours. Pericarditis and endocarditis, advanced phthisis, pleuritis, erysipelas, acute rheumatism, purulent meningitis, pharyngitis, diphtheria, septicæmia, osteo-myelitis, scarlet fever, variola, some profound anæmias, whether primary or secondary, leucæmia, hemorrhage, malignant new growths, abscess of any kind, including appendicitis, and many skin diseases, are among the others that show leucocytosis. The diseases in which the leucocytes are approximately normal are malaria, tubercular meningitis, tubercular and serous peritonitis, influenza, measles, typhoid fever, and pulmonary phthisis unless there is a secondary infection by other bacteria. Comparing these two lists, you will see that there are some cases in which the leucocyte count may be of great importance to the physician in making a differential diagnosis. By

its aid we may in some cases differentiate scarlet fever from measles, a purulent from a tubercular meningitis, and a beginning pneumonia from a tubercular meningitis or typhoid fever. Lastly, we may by the leucocyte count alone be able to decide between sepsis and malaria in a patient whose only symptoms are malaise and returning chills.

**LEUCÆMIA.**—The disease called leucæmia sometimes occurs in infancy and childhood. Klebs, von Jaksch, and Sängner describe congenital cases. On the whole, it is a rare disease in infancy, and when it occurs it is probably always a mixed form. A pure myelogenous form of leucæmia is very rare. The etiology of the disease is obscure. Cases have been reported which followed congenital syphilis and rhachitis. It is thought by some to be an infectious disease, but the evidence is insufficient. Von Limbeck thinks that it is a disease of the lymphatic system. Others say that any anæmia or Hodgkin's disease may progress to leucæmia under certain circumstances, as may also anæmia infantum pseudo-leukæmica. A number of cases are apparently primary. This is one of the few diseases which can be diagnosticated definitely from the blood-examination alone.

Speaking of the hæmatology of leucæmia, we find that it occurs in two distinct varieties, according as the lymph-glands or the spleen and bone-marrow have been most affected. I will begin with a short description of the latter, the spleno-myelogenous. The first and perhaps the most striking thing that you will notice in examining the blood is the great increase in the leucocytes. Von Jaksch reports a case in an eighteen-months infant where the figures were 1 to 18, and another in which the astonishing ratio of 1 to 2.5 was found. But a leucocytosis alone, even a profound one, does not make a leucæmia; it is the especial kind of leucocyte that you must depend upon, the so-called myelocytes, or "markzellen" of Ehrlich (Plate V., 8*a*, facing page 330). These cells, which are said never to be found in normal blood, are present in this disease in varying proportions up to 20 per cent. of the entire leucocyte count, or even higher. Associated with these there may be the eosinophilic markzellen (Plate V., 8*b*, facing page 330), which Rieder and others have held to be equally diagnostic; also the dwarf eosinophiles (Plate V., 4*b*, facing page 330), which differ only in size from the ordinary polynuclear eosinophilic cells. These three varieties of elements are found in great numbers in the marrow of the long bones, and thence are supposed to get into the blood. Of the forms of leucocytes with which you are familiar in normal blood you may find the polynuclear eosinophiles increased. Their variation was thought at one time to be of diagnostic importance, but it is now considered to be of no value. The polynuclear neutrophiles are normal, or frequently are relatively diminished and vary in size more than usual. The lymphocytes in pure spleno-myelogenous leucæmia are always diminished. Karyokinesis is marked in the leucocytes. The erythrocytes you will find reduced, but never so much so as in the primary or even the secondary anæmias. The percentage of hæmoglobin decreases proportionately with the number of red globules or slightly in



advance of it. Lastly, nucleated red cells appear, mostly normoblasts, though megaloblasts are not very rare in children.

Turning now to the second or lymphatic variety, the blood-picture is very different, though quite as distinctive. In this the leucocytes are never so greatly increased, and seldom exceed the proportion of 1 to 15. The diagnosis rests upon the wonderful relative increase of the lymphocytes. These, as you know, should make 25 to 60 per cent. of the entire leucocyte count, according to the age of the child; but in this form of leucæmia 90 per cent. and over has been reported, even in adults. Relative to these, all the other leucocytes are diminished. The special cells, which I have told you are found in varying proportions in the spleno-myelogenous form, are rare; perhaps their occasional presence may be explained by a slight involvement of the bone-marrow, even in the purest lymphatic form.

CASE 115. (Damon and Cheever.)



Warren Museum, Harvard University. Lymphatic leucæmia. Boy, 8 years old.

This case (Case 115), the history and picture of which I have brought from the Warren Museum to show you, is that of a boy eight years old, reported by Dr. H. F. Damon. He had shown symptoms of enlarged cervical glands for a year, but his general health had been fairly good. He never had any pain in the glands, and was well enough to go to school. An examination of the blood showed that the relation of the leucocytes to the erythrocytes varied from 1 to 50 to 1 to 10.

Two months previous to the time when this picture was taken, the tumor had increased rapidly, and you see it is of considerable size, involving the entire left side of the neck. The boy complained at this time of headache, which probably was caused by pressure on the recurrent vessels of the neck. The mass of impacted glands had begun evidently to press upon the trachea, and on exertion the respiration was slightly interfered with. On palpation the tumor was found to consist of many lobules, which were to some extent movable, and appeared to be made up of an enlarged chain of lymphatic glands. It extended



from near the middle line of the neck in front, back upon the edge of the trapezius on the left side, and above from the lobe of the ear and angle and body of the lower jaw down to and beneath the clavicle. The left shoulder was depressed by it. A number of enlarged cutaneous veins ran over it in various directions. As the tumor showed no signs of softening, but was steadily enlarging, it was deemed best to attempt its removal. The operation was performed by Professor D. W. Cheever. An incision was made from just below the ear to near the cricoid cartilage, through the skin and platysma, and disclosed a lobulated, hard, glandular mass, lying mainly beneath, and partly behind, the sterno-mastoid muscle. Contrary to expectation, it was found very adherent in all directions, and the lobules were bound together by strong fibrous tissue. Considerable time and care were requisite to divide the adhesions, which were too strong to yield to anything but the edge of the knife. It was found necessary to divide the sterno-mastoid, and to dissect aside the external jugular, which ran, somewhat displaced, over and through the tumor. The lower edge of the tumor extended beneath the clavicle, into and below the subclavian triangle. The base lay over the sheath of the carotid, which was necessarily exposed for about two inches. Continuous dissection was required, even to the last adhesion, for they could nowhere be made to yield.

The boy recovered in a few weeks, a large part of the wound healing by first intention.

The tumor was found to consist of a lobulated mass of hypertrophied lymphatic glands, firmly bound together by investing fibrous tissue.

Two years after the operation the child was alive and fairly well, although the glands on both sides of the neck were again found to be considerably enlarged, as were also those in the axillæ. The further history of the case is unknown, and the report is in many ways unsatisfactory, but the facts as stated are all that I could ascertain about it. There is no doubt in my mind that it was a case of leucæmia.

The second general class, which I have referred to as liable to occur in many diseases, is oligocythæmia.

**OLIGOCYTHÆMIA.**—The anæmias are of common occurrence in infancy and childhood. Our ordinary methods of examination are evidently insufficient to discover the causes of the anæmia. It seems as if in the future we must direct our attention to other methods of investigation, and especially to the examination of the blood-serum. It may be of interest to refer briefly to Maragliano's recent theory regarding the blood-serum and its action on the corpuscles. Maragliano's researches upon the blood-plasma have tended to show the various relations existing between the organs and the blood. Pronounced local pathological changes influence the composition of the blood-serum, so that in consequence of this the corpuscles later are destroyed. The length of time required to produce this result depends upon their resistance. These observations throw light on a number of clinical results, and on the dependence of the anæmias upon severe pathological disturbances. Maragliano found that the erythrocytes, when pathological conditions were present in the serum, were rapidly destroyed, whereas in healthy serum they remained almost intact. He examined the blood serum in various diseases, as, for instance, the essential anæmias of all grades, carcinoma, saturnismus, spleno-myelogenous and lymphatic leucæmia, purpura, cirrhosis of the liver, nephritis, pneumonia, typhoid fever, erysipelas, and tuberculosis. In all these diseases the serum has a destructive effect on the corpuscles as compared with normal serum, but with quantitative differences depending on two factors: (1) the

vulnerability of the red corpuscles, and (2) the destructive power of the serum. If both of these factors work together, the effect produced is extreme. He is very cautious about explaining the cause, but denies any definite relation between the amount of albumin and the destructive power of the serum, and rather inclines to the belief that the quantity of salts in the serum has some influence. While the erythrocytes are being destroyed, however, the blood-making organs are undergoing an increased functional activity, and producing erythrocytes to supply the loss. Maragliano concludes that different conditions of the serum produce in the red corpuscles all the appearances of necrobiosis, and can even destroy them. This gives an anatomical, physiological, and pathological basis for our belief in independent diseases of the blood. This theory concerning the blood-serum is at least plausible, and until it has been proved incorrect it may be accepted. Perhaps this necrobiotic power of the serum, which depends on some previous disease, varies in different diseases and in different individuals. Even if it is present in sufficient amount to cause anæmia in a given case, it may not do so because of the resistance of the blood-corpuscles to its influence. The variation in these two factors—namely, the resistance of the red corpuscles and the destructive power of the serum—will account for the variation in the degree of anæmia produced in different individuals having the same disease.

We know that in distilled water the coloring matter of the red corpuscles is extracted from the stroma, but when a certain percentage of sodium chloride is added to the water the integrity of the red corpuscles is preserved. That the erythrocytes are not normally destroyed by the serum in which they float seems to depend upon the presence of a sufficient quantity of salts in the serum. A serum in which there is just enough saline matter to preserve the red corpuscles has been called by Hamburger "isotonic." But as an isotonic serum would easily lose its protective properties, owing to its dilution after each meal, we generally find a higher salt percentage than is necessary to preserve the red corpuscles,—a condition designated by the term "hyperisotonic."

From experiments upon animals it has been proved that the serum possesses powerful germicidal properties, which are easily destroyed by raising the blood to a temperature of 55° C. (131° F.) for a short time or by exposing it to light. Still more singular is the fact that not only does the mixing of the serum of one animal with the blood of another of a different species destroy its germicidal power, but also that the added serum acts as a solvent for the red corpuscles and renders the white corpuscles inactive. There is considerable reason to believe that immunity from a given disease depends upon the character of the serum; and Klemperer is now carrying on some interesting experiments with a view to producing immunity by serum inoculation.

In regard to what are usually looked upon as primary anæmias, we can speak of such diseases as chlorosis, pernicious anæmia, and anæmia infantum



pseudo-leukæmica (von Jaksch). By far the greater number of anæmias in early life are, however, of secondary origin. Hemorrhage, the acute infectious diseases, syphilis, rhachitis, new growths, intestinal affections, and diseases of the respiratory system, skin, and bones, are the ordinary causes of secondary anæmia. The degree of the anæmia depends upon the individual, upon the severity and length of the disease, and upon other causes which are as yet unknown. The secondary anæmias may be either of a mild or of a severe form, and may be accompanied or not by a greater or less degree of leucocytosis. The mild forms are usually spoken of as *anæmia chronica levis*, while the severe forms may be called *anæmia chronica gravis*. The blood in these cases shows a varying degree of oligocythæmia and oligochromæmia, with or without leucocytosis, and, if severe enough, poikilocytosis, microcytosis, and at times nucleated red corpuscles. The latter are the more frequent the younger the child, and generally occur during the first year. They are never very numerous in these cases, and are, as a rule, of the normoblast type.

PRIMARY ANÆMIAS.—Poor as the classification of the anæmias into primary and secondary may be, it will, I think, keep the subject more clearly before your minds if I follow this very imperfect division, which for purposes of simplicity it has seemed almost necessary to make. I shall therefore speak at once of the anæmias which are supposed to be primary and which I have just enumerated, wishing it, however, to be understood that I use the word *primary* only provisionally until further light is thrown upon this class of diseases.

Chlorosis.—Although it is still a matter of dispute whether chlorosis should be classed as one of the anæmias, it will simplify what I have to say on this subject if I speak of it as such.

Weiss doubts if chlorosis occurs in infants and young children, but the observations of Hensch and others tend to show that it does. The distinguishing characteristic of the disease is the very low percentage of hæmoglobin relatively to the nearly normal number of erythrocytes, which is in marked contrast to that found in other diseases, especially progressive pernicious anæmia. There is very little or no leucocytosis. Considerable variation in the size of the erythrocytes occurs, poikilocytes, microcytes, and macrocytes being often found.

In this connection I will refer you to some interesting work on the intestinal origin of chlorosis which has been done by Dr. Forchheimer, of Cincinnati, and to his original views and new definition of this disease.

This infant (Case 116), eighteen months old, has never had the symptoms of any special disease beyond a pallor of the nails, skin, lips, and mucous membrane of the gums, with loss of appetite and strength. This has lasted for about six months, and does not appear to depend on climate or habitation, as the infant has been during this period in a number of houses, both in the city and at the sea-shore. An examination of the blood showed that it was a case of chlorosis, the erythrocytes being somewhat reduced and there being a decided oligochromæmia.



BLOOD EXAMINATION 3. (Wentworth.)

Erythrocytes . . . . .	4,427,500.
Hæmoglobin . . . . .	35 per cent.

(The infant gradually improved under a course of treatment which was largely dietetic.)

The next case (Case 117) which I have to report is that of a female infant, eleven and one-half months old. The pallor of the lips, gums, skin, and nails in this case was extreme, and was accompanied by loss of appetite, but no especial emaciation. The blood examination gave the following result:

BLOOD EXAMINATION 4. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,470,000
Hæmoglobin . . . . .	30 per cent.
Leucocytes . . . . .	25,000
Small mononuclear . . . . .	45 per cent.
Large       "       . . . . .	21   "
Polynuclear . . . . .	30   "
Eosinophiles . . . . .	3   "

The cause of the chlorosis was apparently arsenical poisoning from wall-papers. The chlorosis was always extreme during the nine months of the year when the infant was in its winter home, and was unaffected by treatment, either dictetic or medicinal. During the three summer months that it was away from home it decidedly improved, but it immediately grew worse on returning. The papers throughout the house in its winter home were found to be dangerously arsenical, and on their removal the infant rapidly improved, and in a few weeks regained its healthy color, strength, and appetite. If the chlorosis in this case was caused by arsenic, it must of course be classed with the secondary anæmias.

Both these cases illustrate the fact that extreme pallor does not necessarily indicate a great reduction in the number of the erythrocytes.

The symptoms of this disease as met in infants are progressive loss of appetite and of strength, and extreme pallor of the skin and of the mucous membrane, not accompanied, as a rule, by marked emaciation.

**Anæmia Progressiva Perniciosa.**—I shall next speak of a very severe form of primary anæmia, the prognosis of which is so serious that it is called *anæmia perniciosa*.

Biermer in 1868 described a disease under the above title, and said that it developed apparently without any cause and by a gradually increasing and constantly progressing anæmia caused death. The pathological and anatomical changes consisted in a great diminution in the amount of blood in all the organs, with marked fatty degeneration of the heart, blood-vessels, liver, and kidneys. Capillary hemorrhages were frequently found. Since then a mass of literature has been accumulating on the subject. Various authors have observed cases in infancy and in childhood. Most of the cases, however, were over a year old, and it is certainly not a common disease of early childhood. The description of the disease does not differ materially from

that of adults. There is an apparently spontaneous beginning in most cases. Klebs and Frankenhäuser thought that they found certain micrococci in the blood, but this has not been proved. Cases have been recorded which have developed as a result of congenital syphilis, and there are other cases in which the presence of such intestinal parasites as the *anchoylostoma duodenalis* and the *bothriocephalus latus* have appeared to be followed by it. Cases have also apparently followed repeated hemorrhages. The majority, however, occurred without any discoverable cause.

The blood in pernicious anæmia is thin and light-colored, and all the formed elements are markedly decreased. The enormous diminution of erythrocytes, which is more marked than in any other disease, even in the highest grade of simple secondary anæmia, the relatively high hæmoglobin percentage, due to the large amount of hæmoglobin in each corpuscle, and the presence of megaloblasts in large numbers, are considered to be diagnostic of this disease. Poikilocytosis is usually pronounced. Microcytes and macrocytes are common. There is generally a diminution in the number of leucocytes, the prevailing type being mononuclear, but at times we find a distinct leucocytosis. It has been pointed out by von Jaksch that the degree of leucocytosis is never so great as in anæmia infantum pseudo-leukæmica. Eosinophilic cells are, as a rule, present in unusual numbers. Myelocytes in small numbers are not infrequently found. Clinically the disease does not differ from that of the adult. It is the severest type of all the anæmias, and all the cases have proved fatal, except those in which intestinal parasites were found to be the cause and were removed before the disease had become fully established.

This infant (Case 118), six months old, is apparently a case of pernicious anæmia, although the blood examination does not entirely establish the diagnosis. It entered the hospital when it was five and one-half months old, with the history of having been fed on a variety of patent foods from the time of its birth. On physical examination nothing abnormal was found in the abdomen or thorax, and it was not especially atrophic. Its weight was 2841 grammes (6½ pounds). It now weighs 2915 grammes (6¾ pounds). Since entering the hospital it has failed to respond to treatment of any kind, whether dietetic or medicinal, and has become more and more anæmic. You will notice the extreme pallor of the mucous membrane of the gums and of the entire skin. The following is the report of the examination of the blood :

#### BLOOD EXAMINATION 5. (Whitney and Wentworth.)

Erythrocytes . . . . .	2,937,500
Hæmoglobin . . . . .	35 per cent
Leucocytes . . . . .	5,500
Small mononuclear . . . . .	55 per cent.
Large " . . . . .	10 "
Polynuclear . . . . .	35 "
Eosinophiles . . . . .	5 "

(The infant continued to fail progressively, and died about two months later. The temperature and pulse were practically normal through the whole course of the disease,



and nothing abnormal was at any time detected in the thorax or abdomen. There was no autopsy. A few days before death there appeared extensive hemorrhages under the skin of the abdomen.)

This infant (Case 119), seventeen months old, presents the typical appearance of a pernicious anæmia. On entering the hospital it weighed 5925 grammes (13.03 pounds), and has been progressively losing, until this morning its weight was only 5798 grammes (12.75 pounds). It is emaciated and has had but little appetite, but it has evinced a desire to eat any dirt that it can lay its hands on. A physical examination reveals nothing abnormal, such as thoracic disease, enlarged spleen, or enlarged lymph-glands. The skin has the transparent rather waxy appearance (well represented in Plate V., facing page 330, *Anæmia Infantum Pseudo-Leukæmica* von Jakseh) which occurs in anæmias of the highest grade.

CASE 119.



*Anæmia perniciosa.* Female, 17 months old.

She is rather apathetic, in fact, almost dull, and can be handled and examined without any apparent discomfort. The result of the blood examination is very significant:

BLOOD EXAMINATION 6. (Wentworth.)

Erythrocytes . . . . .	1,022,500
Hæmoglobin . . . . .	17 per cent.
Leucocytes . . . . .	16,000

The next case (Case 120), an infant nine months old, was seen by me in consultation with Dr. C. P. Putnam, who has kindly provided me with its previous history. The infant was healthy at birth, and up to the time of its present sickness had never had any disease. For several months it had progressively grown pale, and its appetite had decidedly lessened. It had not, however, lost materially in weight, but had grown weak physically, and its mental hebetude had been so noticeable that a suspicion had arisen that it was lacking in cerebral development. On inspection the infant seemed moderately fat, but the muscles were soft, and the skin was of an extremely pale and waxy tinge. It was evidently very weak. On physical examination nothing abnormal was detected about the head, thorax, or abdomen. All the organs seemed to be of natural size. An examination of the blood, made by Dr. Dane, resulted as follows:

BLOOD EXAMINATION 7. (Dane.)

Erythrocytes . . . . .	1,571,000
Hæmoglobin . . . . .	22 per cent.
Leucocytes . . . . .	19,100
Small mononuclear . . . . .	42 per cent.
Large " . . . . .	18 "
Polynuclear . . . . .	40 "
Eosinophiles . . . . .	0 "



You will notice the great reduction in the number of red corpuscles, the relatively large percentage of hæmoglobin, and the slight increase of white cells. The differential count gives us no special information in regard to the cause or character of the disease. (The child died a few days later without showing any other symptoms.)

The next case is the fourth in which the clinical history and the great oligocythæmia seemed to point towards anæmia perniciosa as the most probable disease, but no elaborate blood examination was made.

A female infant (Case 121) entered my wards at the Children's Hospital on the 16th day of April. She was then nine months old. Nothing abnormal was detected in the lungs or heart, and there was no appreciable enlargement of the liver, spleen, or lymph-glands. The pulse varied from 120 to 140, and the temperature from 36.7° C. (98.06° F.) to 37.8° C. (100.04° F.). The respiration was from 44 to 68. There were hemorrhagic spots on the ankles and head for a few days, but these soon passed away, and nothing abnormal was detected except extreme pallor of the skin, progressive loss of appetite, emaciation, and quick respiration. The erythrocytes were reduced to 785,000, and there was marked poikilocytosis. There was a slight amount of albumin in the urine. The infant grew rapidly worse on April 22, and died in the evening. There was no autopsy.

**Anæmia Infantum Pseudo-Leukæmica** (von Jaksch).—I shall now speak of a form of chronic primary anæmia where, in order to make a differential diagnosis, we must consider the etiology and physical signs as well as the blood examination.

Von Jaksch, in 1889 and 1890, was the first to describe this disease and give it this title. Since then it has been the subject of much investigation and contention. Von Jaksch based his diagnosis on the following points: that it was a disease of infancy, characterized by marked oligocythæmia, oligochromæmia, considerable permanent leucocytosis, marked splenic enlargement, at times enlarged lymph-glands, only moderate or slight enlargement of the liver, and clinically to be differentiated from leucæmia by the disproportion existing between the size of the liver and the spleen. The more favorable prognosis is also an aid in the diagnosis. About the same time Hayem described a similar disease in a child, and noted the presence of numerous nucleated red corpuscles. Von Jaksch had noticed them, but had mistaken them for leucocytes having erythrocytes inside of them. Hayem noted especially that many of the nucleated red corpuscles were undergoing mitosis. This had never been observed before in the circulating blood.

Luzet verified Hayem's observations. He described this as a disease of early infancy, and emphasized the chronic course, the intense anæmia, and the large size of the spleen and the liver without enlargement of the lymph-glands. He only found a slight leucocytosis, in which the eosinophiles were quite numerous. He considers the large number of nucleated red corpuscles, many of them showing mitosis, as especially important for diagnosis. This condition he has not found so marked in any other disease of the blood. He considers this one of the rare affections of infancy, as according to his statistics it was met only once in fifteen hundred cases of anæmia, and

he thinks that it does not occur after two years of age. The effects of sex, temperament, habitation, heredity, and climate are not known.

He thinks that rachitis and syphilis, which at times produce anæmia, with enlarged spleen, do not cause anæmia infantum pseudo-leukæmica. Loos, Weiss, Somma, and others have written a great deal about this disease. Some of them consider it an infectious disease. Most of them deny that it has any connection with malaria, syphilis, and the digestive disturbances, and only occasionally mention its connection with rachitis.

As a result of my investigations of a considerable number of cases of anæmia of every grade in young infants, it seems to me that we have arrived at a degree of knowledge which justifies us in making a diagnosis, in certain cases, of anæmia infantum pseudo-leukæmica von Jaksch, and I shall presently show you some cases illustrative of this disease. We are dealing with a disease of infancy characterized by a chronic course, rather rare occurrence, and etiological obscurity. The clinical symptoms are those of a grave anæmia, with a "waxen" appearance of the skin. The child may be somewhat atrophied, but is often fairly nourished. There is always considerable splenic enlargement, with only moderate or slight enlargement of the liver. The lymph-glands are generally somewhat enlarged, but never form packets. The blood is characterized by marked oligocythæmia and oligochromæmia, together with a leucocytosis which is often considerable. Nucleated red corpuscles of all types are very numerous, and many of them are found to be undergoing mitosis in their nuclei. Poikilocytosis is marked. The polychromatophilic condition of the red corpuscles, mentioned by Alt and Weiss, may occur. The eosinophilic cells vary in number, and at times are much increased. They also vary considerably in size. Occasionally small numbers of the large mononuclear neutrophiles and the eosinophilic "markzellen" of Müller and Rieder are found. (Klein.)

The course of the disease varies. Von Jaksch lays stress on the more favorable prognosis as compared with leucæmia. All of my cases have been fatal without any apparent complication, and even if the disease remains stationary for a time the risk from intercurrent disease is great. Four cases which apparently can be classed as representing this disease have occurred in my practice. The first case (Case 122) you will remember seeing in my wards at the Children's Hospital, and may be described as follows :

A boy, three years of age; had never had any disease, with the exception of a questionable malaria, from which he had entirely recovered two years previously. The father said that since his second year he had looked pale, and that a physician was consulted about him eight months before he entered the hospital. He entered my wards on October 4. The child, as you will remember, was of a waxen color, well shown in Plate V. (facing page 330), and the mucous membrane of the lips and nails was nearly white, with a livid tinge. The skin was almost translucent. There was not much emaciation. The spleen was considerably enlarged, and could easily be felt about two inches below the border of the ribs. The liver was slightly enlarged and could be felt upon palpation. The glands were enlarged



to the size of peas in the neck, axillæ, and groins. On percussion the heart showed no enlargement. A loud systolic murmur was heard over all the cardiac orifices. The action of the heart was very rapid, but regular. Its impulse was in the fifth interspace inside of the mammary line. Auscultation and percussion of the lungs showed that they were normal, with the exception of some sibilant râles. The respirations were 30 to 44 in a minute.

CASE 122.



Anæmia infantum pseudo-leukæmica von Jaksch. Male, 3 years old. Lower border of ribs, enlarged liver, and spleen outlined in black.

The temperature at entrance was 38.3° C. (101° F.), and afterwards varied from 39.5° C. (103.8° F.) to about 38.3° C. (101° F.). The pulse varied from 125 to 150. Diarrhœa was present when the child entered the hospital, and at first there were four to six very offensive movements daily. For three or four days preceding death the movements were more frequent, but were not so offensive, and contained mucus. Vomiting occurred at times. The infant was treated with modified milk, bismuth, and stimulants. An examination of the blood, October 13, resulted as follows:

BLOOD EXAMINATION 8.

Erythrocytes . . . . .	1,295,000
Hæmoglobin . . . . .	15 per cent.
Leucocytes . . . . .	64,500

There were numerous poikilocytes, microcytes, and megalocytes. A number of the corpuscles were pale, and many of them contained very little hæmoglobin.

The polymorphous character of the blood was very marked. There were numerous *nucleated red corpuscles* (Plate V., 6, facing page 330), chiefly of the normoblast type, and in many of them the nuclei were undergoing subdivision. The *eosinophiles* were absolutely and relatively increased. None of the "markzellen," characteristic of leucæmia, were present, and the leucocytes were largely of the polynuclear variety. The child died October 20, and a partial autopsy was obtained.

A microscopic examination showed no evidence of leucæmia in the liver, spleen, kidneys, or lymph-glands. There were no evidences of syphilis or rhachitis, nor of any inflammation which could have caused the leucocytosis.



My second case (Case 123) of this disease I happen to have here in the wards to-day to show you. It is a male infant, eleven months old.

The previous history of the infant has not been ascertained, as the parents have disappeared. You see that he is poorly developed and somewhat emaciated. The skin has a waxen color, and the mucous membrane of the lips and gums is almost colorless. The dejections are frequent; they contain partially digested blood, and have so offensive an odor that disinfectants are constantly required in the room. The cervical lymph-glands and those in the groins are slightly enlarged. I find nothing abnormal on examining the

CASE 123.



Anæmia infantum pseudo-leukæmica von Jakseh. Male, 11 months old. Left lower border of ribs, ensiform cartilage, and enlarged spleen marked in black.

CASE 123.



Anæmia infantum pseudo-leukæmica von Jaksch. Male, 11 months old, crying. Right lower border of ribs, ensiform cartilage, and enlarged liver marked in black.

heart and lungs. Palpation of the abdomen reveals a large tumor of firm consistency, beginning under the lower border of the ribs in the left axillary line, and extending towards and considerably below the umbilicus. This tumor is evidently the spleen, and you see I have outlined its edge in black. On the right side of the abdomen the edge of the liver can be felt just below the ribs. I have outlined this edge in black. There appears to be no tenderness of the bones or enlargement of the epiphyses such as would occur in rhachitis, and there is no evidence of syphilis. The following examination of the blood has just been made by Dr. Wentworth:

BLOOD EXAMINATION 9. (Wentworth.)

Erythrocytes . . . . .	1,311,250
Hæmoglobin . . . . .	20 per cent.
Leucoeytes . . . . .	116,500
Small mononuclear . . . . .	46 per cent.
Large " . . . . .	34 "
Polynuclear . . . . .	16 "
Eosinophiles . . . . .	4 "

A drop of the blood, you see, is watery and of a pale red color, but the corpuscles themselves you will observe on this slide under the microscope are not markedly pale. The erythrocytes vary much in size and shape, *poikilocytes*, *microcytes*, and *macrocytes* all being present. In fact, the *polymorphous* character of the blood is very pronounced, the normoblast type of the erythrocytes predominating. Mitoses are very frequent, and show all varieties of subdivision, many of the erythrocytes having two nuclei, others, being in process of subdivision, showing three and four segments. Many of the nuclei also lie eccentrically in the cells. The leucoeytes are very variable in this case, but the mononuclear type prevails. The eosinophiles are relatively and absolutely increased, but are somewhat smaller than usual, and are polynuclear.

(The infant failed rapidly and died. No autopsy was obtained.)

My third case in the series is one in which the blood examination was so unsatisfactory that there is a possibility of my being mistaken in my opinion that it should be placed under the heading of anæmia infantum pseudo-leukæmica. It would seem, however, from the history, and from the physical examination, that it can better be considered a case of this disease than of secondary anæmia.

A male infant (Case 124), twelve months old, entered the hospital August 15, with the following history. The mother was healthy, the father was said to be tubercular. There were three other living children said to be healthy, and one child, a boy seven years old, was said to have died from some disease of the brain. The infant was healthy at birth, was nursed by its mother and thrived until it was five months old, when patent foods of various kinds were given to it, and it was nursed irregularly. It then began to have digestive disturbances. On examination it presented so typical a picture of the two cases (Cases 122, 123) which I have just described as representing anæmia infantum pseudo-leukæmica that I have had this colored sketch made of it. (Plate V., facing page 330.) You will notice the intense pallor of the entire skin, which has the "waxen" color in a pronounced degree. The transparent ears are very noticeable, and, as you see, I have mapped out the border of the enlarged spleen in black. The inguinal glands were slightly enlarged, and the liver was scarcely perceptible beneath the margin of the ribs, but the spleen was enormously enlarged, extending down into the left inguinal region as far as the crest of the ilium. There were no other enlarged glands detected. The abdomen was rather distended, and the infant was not especially emaciated. It had had convulsions from time to time since it was five months old. There was no evidence of rachitis or of syphilis. An analysis of the mother's milk made on August 25 was as follows:

ANALYSIS 56.

Fat . . . . .	1.91
Milk-sugar . . . . .	6.45
Proteids . . . . .	2.66
Mineral matter . . . . .	0.17
Total solids . . . . .	11.19
Water . . . . .	88.81
	<hr/> 100.00



The examination of the blood gave the following results :

BLOOD EXAMINATION 10. (Whitney and Wentworth.)

*I. August 25. II. October 17. III. November 9. IV. December 19.*

I. Erythrocytes	1,585,000
(All of large size and normal red color.)	
Hæmoglobin	30 per cent.
Leucocytes	(The estimate was too doubtful and unsatisfactory to report.)
Small mononuclear	61 per cent.
Large " "	23 " "
Polynuclear	14 " "
Eosinophiles	2 " "
Megaloblasts and normoblasts in moderate numbers.	
II. Erythrocytes	3,215,000
Hæmoglobin	46 per cent.
III. Erythrocytes	3,300,000
Hæmoglobin	45 per cent.
Leucocytes	
Small mononuclear	58 " "
Large " "	45 " "
Polynuclear	8 " "
Eosinophiles	8 " "
IV. Erythrocytes	3,925,000
Hæmoglobin	40 per cent.

(Treatment of various kinds, both medicinal and dietetic, appeared to have no effect upon the patient's general condition, and when last heard from it was growing progressively weaker and more anæmic.)

I am fully aware that without the count of the total leucocytes the diagnosis is not proved. There should have been found a decided leucocytosis, which I shall assume to have been the case, as all the other characteristics of the disease were present.

The fourth case which I shall speak of as one of anæmia infantum pseudo-leukæmica occurred some years ago in my practice, and, as no reliable examination of the blood was made, I cannot, of course, accept the diagnosis as proved. It was, however, so interesting that it is well to put it on record, as it may in the future be valuable in comparison with cases having similar clinical symptoms, especially as an autopsy was obtained.

The infant (Case 125), a male, was first seen and examined by me when it was four months old. The parents were healthy, and there was one older child, also healthy. There was no history of hereditary disease in the family. Their home was in a comfortable country house, well built, with good drainage, an unpolluted water-supply, and no arsenic in the papers, curtains, or furniture-coverings. The house was built on a considerable elevation, and was not in a malarial district. The infant was healthy at birth, and weighed 3750 grammes (8½ pounds); it was nursed for a short time, and was then fed with various artificial foods. It soon began to show digestive disturbance and to grow pale. It lost somewhat in weight, had a gradually lessening appetite, and at times vomited.

On physical examination nothing abnormal was found in the thorax or abdomen. There were no enlarged glands. The symptoms were entirely those of functional indigestion, and under a proper regulation of the diet it improved somewhat for a time, and there was a gain in weight.



Two months later I again saw the infant, and, with the exception that the pallor of the skin had much increased, nothing abnormal was discovered. The infant was brought to the Children's Hospital to be under my care when it was eight months old. I then found that it had a much enlarged spleen. The liver and lymph-glands were not enlarged. There was a slight albuminuria. The erythrocytes were reported to be diminished and the leucocytes increased. Its weight was 6704 grammes ( $14\frac{3}{4}$  pounds). A few hemorrhagic spots were reported to have been seen on its legs and thorax before entering the hospital, but they were not present on entrance. The infant began to fail soon after coming to the hospital, and died a week later, the spleen having decreased in size. On the day of its death it became very restless and cried a great deal, putting its hands to its head. Nothing abnormal was found on examination of the ears. Slight œdema was detected at the base of both lungs a few hours before death, and it finally died rather suddenly. The following is the report of the autopsy made by Dr. W. F. Whitney:

The body was that of an apparently well-nourished infant, and externally the only remarkable feature was the extreme pallor.

The lungs were normal and retracted.

The heart was of normal size and shape and without any malformation. A microscopic section showed an occasional granular fibre. The spleen was slightly enlarged, firm, and somewhat pale. Microscopic examination failed to show any deviation from the normal structure. The stomach and intestines presented nothing abnormal. The liver was of normal size, its consistency was firm, and its appearance was marked on section by a pale whitish color, which was everywhere present, and had no relation to any part of the lobules. Microscopic examination showed that the liver-cells were separated by large spaces, looking at first like dilated capillaries, filled with small cells similar to leucocytes. The appearance was very similar to that of a foetal liver of the fifth month. Chemical tests failed to show the presence of any free iron in the liver-cells. The kidneys and other organs presented nothing abnormal.

**SECONDARY ANÆMIAS.**—The secondary anæmias are so numerous and arise from so many different causes that an exhaustive discussion of them would hardly be practicable in a clinical lecture. You must bear in mind what I have already said regarding them: first, that almost every anæmia which we meet with is secondary,—that is, that it arises somewhere outside of the blood-making organs; second, that in almost every disease of any organ a secondary anæmia is liable to arise, and is of a high or a low grade according to the severity of the disease. The changes in the form-elements of the blood which are found in these secondary conditions are simply the constant occurrence of oligocythæmia and oligochromæmia, the presence or absence of leucocytosis, and the absence of the other characteristics which are supposed to belong to chlorosis, anæmia perniciosa, and anæmia infantum pseudo-leukæmica von Jaksch. Where the leucocytosis is great, the anæmia is usually one of the graver forms, and in these grave anæmias the leucocytes are found to vary from 14,000 to 54,000. You may remember this infant (Case 126, page 366), four months old, which I examined before you in the wards of the Infants' Hospital six weeks ago. It represented at that time what I shall later describe to you as a moderate grade of infantile atrophy. It was much emaciated, and the interference with the normal activity of the intestinal absorbents was seriously affecting its nutrition. It was pale, but did not have the "waxen" pallor which I have described in previous cases.

A blood examination at that time gave the following result, which was simply that of a moderate grade of anæmia :

BLOOD EXAMINATION 11. (Wentworth.)	
Erythrocytes . . . . .	3,006,250
Hæmoglobin . . . . .	40 per cent.
Leucocytes . . . . .	11,500

The treatment was by food adapted to the disabled condition of the absorbents,—namely, a low percentage of fat with a rather high percentage of sugar and a moderately high percentage of proteids. You see what a marked change has occurred in the appearance of the infant, which has grown fat and is no longer anæmic.

CASE 126.



Male, 4 months old. Infantile atrophy of medium grade, with moderate anæmia.

**TREATMENT.**—With the exeption of the case last spoken of, you will notice that up to the present time I have said nothing whatever as to the treatment of these diseases of the blood. I have done this purposely in order to impress upon you that in infants and young children these diseases depend, so far as I can ascertain, almost entirely upon some interference with the nutrition. It is very rarely that I give drugs in any form in these diseases. The treatment of anæmia pernicioso and anæmia infantum pseudo-leukæmia von Jaksch, either with or without iron, arsenic, or other drugs, is well known to be ineffectual. On the other hand, the treatment of ehlorosis and the secondary anæmias has, in my experience, been followed usually by complete reeovery. This treatment has been, first, to remove the cause, whether it be the inhalation or ingestion of poisons, such as arsenic or impure air and improper food ; second, to adapt the pereentages of the food so as to meet the requirements of the special disease or results of that disease, in order that the infant's nutrition may be thus restored to a state of equilibrium, and the effects of the disease may be eradicated. From this stand-point you will understand that it would be impracticable to enter into the subject of treatment in detail in speaking of the blood as a whole.



The treatment of all these diseases of the blood is merely that of the especial disease which causes the blood-changes, and, as I have just said, is well illustrated by the treatment of this case (Case 126) of anæmia secondary to infantile atrophy. If you thoroughly understand the principle which underlies the treatment and subsequent recovery of this case, you will appreciate the truth of what I have just said, and will be prepared to treat intelligently all the cases which I have already described to you.

The more severe types of secondary anæmia are of great interest and importance in the study of infants and of children. As the grade of the anæmia becomes higher the specific gravity of the blood becomes somewhat lower. In addition to this there is more variation in the size and shape of the erythrocytes. There is poikilocytosis and microcytosis. A few nucleated erythrocytes, generally of the normoblast type, are found. They are, however, not very numerous. The same causes give rise to these grave forms as to the milder forms of anæmia. The terms "syphilitic anæmia" and "rachitic anæmia" are misnomers, as there are no characteristic blood-changes in these anæmias.

**CONGENITAL SYPHILIS, WITH ENLARGED SPLEEN.**—I will now show you a case of congenital syphilis which has been under my care for some time, and in which a number of careful blood examinations have been made. It represents very well the grave secondary anæmia which at times accompanies syphilis; but, as I have already told you, these examinations of the blood show nothing characteristic of syphilis, but merely an ordinary secondary anæmia.

This infant (Case 127) is three months old, and is being nursed by its mother.

CASE 127.



Male, 3 months old. Congenital syphilis. Grave secondary anæmia. Lower border of ribs, fifth rib, and enlarged spleen marked in black.

It was healthy at birth, and remained so until it was three weeks old, when it showed marked syphilitic lesions, which have since become very characteristic. I shall not here enter into a full description of the case, as I shall show it to you again in a few days in connection with some other cases illustrating my lecture on congenital syphilis. The infant,



as you see, is fairly well nourished. You will notice the "waxen" pallor of the skin, so characteristic of the higher grades of grave anæmias. There is a moderate enlargement of the liver, which on palpation is found to be hard and somewhat tender. The inguinal glands are slightly enlarged. The post-aural glands are enlarged. The spleen is much enlarged, and extends, as I have indicated with the black line, from the fifth rib to the left inguinal region. It has, as you see, a peculiar tongue-shaped outline. It is hard, but is not tender. I can detect no other glandular enlargements. The examination of the blood gives the following results :

BLOOD EXAMINATION 12. (Wentworth.)

	Nov. 17.	Nov. 20.
Erythrocytes . . . . .	3,387,000	3,300,000
Hæmoglobin . . . . .	47 per cent.	45 per cent.
Leucocytes . . . . .	20,000	20,000

There is a considerable variation in the size of the erythrocytes, which are pale in color. There is poikilocytosis in a moderate degree ; there are also some microcytes and megalocytes. The mononuclear elements predominate (about three-quarters). The eosinophiles are not numerous.

**RHACHITIC ANÆMIA.**—Rhachitis is so commonly met in early life after the first six months, both alone and in connection with other diseases, that I think it will be well to tell you what is known about the blood before speaking of the separate blood examinations which I have had made in a number of different cases. In this class of cases there is a complete independence of the specific gravity, as influenced by the course of the disease, except when it is complicated by anæmia. When this occurs the specific gravity falls, and it invariably rises as recovery from the rhachitis takes place. Unless this disease is accompanied by a secondary anæmia, the blood is practically normal. Hock and Schlesinger found that if the secondary anæmia was moderate in intensity, and diarrhœa and vomiting occurred, it simply made the anæmia more acute. The majority of the leucocytes were found to be mononuclear and about the size of the erythrocytes. There is a moderate permanent leucocytosis in most of these cases, and at times the mononuclear leucocytes seem to be the most numerous form.

**RHACHITIC ANÆMIA WITHOUT SPLENIC ENLARGEMENT.**—This infant (Case 128), a female, seven months and three weeks old, has just been brought to the hospital for treatment. The enlarged epiphyses of the wrists and ankles, the rhachitic rosary, and the other symptoms which so commonly occur in infants fed on patent foods, indicate that this is a case of moderate rhachitis. The infant is pale and poorly nourished. The blood examination gives the following result :

BLOOD EXAMINATION 13. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,492,000 (occasionally nucleated)
Hæmoglobin . . . . .	70 per cent.
Leucocytes . . . . .	22,000
Small mononuclear . . . . .	33 per cent.
Large " . . . . .	32 "
Polynuclear . . . . .	35 "

**RHACHITIC ANÆMIA WITH SPLENIC ENLARGEMENT.**—This case, which I have under treatment in the wards, is a very interesting illustration of rhachitis with a secondary anæmia of high grade, accompanied by enlargement of the spleen.

The child is three years old, and, as you see, is fairly well nourished. (Case 129.)

CASE 129.



Male, 3 years old. Rhachitis, with enlarged spleen.

It has, however, enlarged epiphyses, a rhachitic rosary, the square rhachitic head, and marked bowing of the legs. On physical examination I find no indication of enlargement of the liver or glands. The spleen is very much enlarged, and I have indicated the position of its outline and its notch, as you see, in black. The blood examination has just been made, and gives the following figures:

**BLOOD EXAMINATION 14. (Wentworth.)**

Erythrocytes . . . . .	2,686,250
Hæmoglobin . . . . .	35 per cent.
Leucocytes . . . . .	13,000
Poikilocytes and marked pallor of the corpuscles were present.	

## LECTURE XVI.

## THE BLOOD IN INDIVIDUAL DISEASES.

TYPHOID FEVER—SCARLET FEVER—MEASLES—VARIOLA—DIPHThERIA—PNEUMONIA—  
BRONCHO-PNEUMONIA—PNEUMONIA AND EMPYEMA—EMPYEMA—MILIARY TUBER-  
CULOSIS—TUBERCULAR MENINGITIS—HYDROCEPHALUS—CHOREA—NEPHRITIS—  
TUBERCULAR PERITONITIS—INFANTILE ATROPHY—PERIOSTITIS—SCORBUTUS—IC-  
TERUS NEONATORUM—SCLEREMA NEONATORUM.

A NUMBER of observations have been made on the blood of children where a condition of fever was present, and a few regarding the specific gravity of the blood in connection with a heightened temperature.

Widowitz found in five-eighths of the cases examined during fever that the hæmoglobin was higher than in the post-febrile period. The remaining three-eighths of the cases had other complications. Regarding the diminution in the number of erythrocytes and the percentage of hæmoglobin after fever, he explains it either as an actual diminution of hæmoglobin or a dilution of the blood by absorption of fluid from the tissues.

Schiff, who has made the most reliable and methodical experiments on this subject, differs from Widowitz in some points. He found a diminution of erythrocytes during the fever and an increase afterwards, and in long-continued fever this was modified somewhat, so that the absolute count was lower. This he considers due to a diminished production, and so a condition of anæmia is gradually produced. He considers the diminution of the erythrocytes in acute fever to be partially due to an increased degeneration of the red corpuscles, and also to the increased metabolism, and not to diminished production. He could not perceive any connection between the normal daily variation of the temperature and the blood-count. He found that the hæmoglobin was diminished at the beginning of the fever, together with the red corpuscles, but that later it was even more marked than the diminution of the red corpuscles, especially when the fever was long continued. He noted cases in which the red corpuscles increased later, but the hæmoglobin remained diminished, or even sank lower.

Regarding the leucocytes in fever, Schiff considers that they do not follow the course of the fever, as regards increase and diminution, except at the beginning, when there is an increase. Some other authors consider that the leucocyte count is not affected by the temperature alone, but that when fever is accompanied by local suppuration the leucocytosis is much more marked. This agrees with the results obtained in adults.

I shall now show you a number of cases in the wards representing different diseases, in each of which a blood examination has been made lately.

**TYPHOID FEVER.**—Arnheim found a striking diminution in the



amount of hæmoglobin after defervescence had occurred, and in spite of an increase in the number of the erythrocytes. In this disease we know that the leucocytes are usually diminished in number, but that there is a proportionate increase in the lymphocytes. (Thayer.) This also occurs in malaria. In the early stages the erythrocytes are increased, as is also the hæmoglobin. In the later stages a condition of anæmia may occur, producing a diminution of the red corpuscles and hæmoglobin.

Here is a girl, eight years old (Case 130), with the clinical symptoms of typhoid fever. The examination of the blood gives the following result:

## BLOOD EXAMINATION 15. (Wentworth.)

Erythrocytes . . . . .	4,602,500
Hæmoglobin . . . . .	60 per cent.
Leucocytes . . . . .	7,000

The next case (Case 131) is also one of typhoid fever, in a boy six years old, and the result of the blood examination is as follows:

## BLOOD EXAMINATION 16. (Whitney and Wentworth.)

Erythrocytes . . . . .	5,496,250
Hæmoglobin . . . . .	64 per cent.
Leucocytes . . . . .	7,000
Small mononuclear . . . . .	14 per cent.
Large " . . . . .	20 "
Polynuclear . . . . .	66 "

As I shall not take you into the contagious wards this morning, I think it will be well, before passing on to the other patients, to remind you in a few words of what we should be likely to find on examining the blood of children with scarlet fever, measles, variola, or diphtheria.

**SCARLET FEVER.**—Widowitz divides the cases of scarlet fever systematically into three groups: *a*, those with a mild course and without complications; *b*, those in which nephritis occurs as a complication; and *c*, those with a malignant course. All three from the beginning showed a high percentage of hæmoglobin, which in uncomplicated cases diminished with the disease, and rose again later without reaching the former high percentage. In the cases of nephritis there was a rapid fall of the hæmoglobin. The malignant cases showed no constant relation. As above mentioned, leucocytosis was generally present, even in the stage of incubation.

**MEASLES.**—Arnheim found in uncomplicated cases no especial changes in the hæmoglobin. He found slight variations, but less than in scarlet fever, and in convalescence the hæmoglobin often reached the high percentage found in the efflorescent stage of the disease. Von Limbeck, Piek, and Rieder found no leucocytosis in uncomplicated cases of measles, and thought this fact of value in the diagnosis from scarlet fever.

**VARIOLA.**—Arnheim found the hæmoglobin diminished at the beginning of the disease. After the formation of pustules and during their exsicc-

cation, he found an increase of the hæmoglobin, with diminution of the erythrocytes. Where complicating suppuration occurred, both the erythrocytes and the hæmoglobin remained for a long time abnormally diminished.

Hayem found in “variola confluens” that the erythrocytes were diminished to two million; in the stage of eruption they were normal, and in the stage of suppuration, in consequence of the concentration of the blood, they were increased. Two weeks after the fall of the temperature they were normal.

R. Pick reports forty-two cases examined by him in which he found no leucocytosis, except in the stage of suppuration or in some complication like pneumonia. The temperature, the severity of the disease, or even a fatal termination, unless complicated as above, produced no leucocytosis.

**DIPHTHERIA.**—Bouchut and Dubrisay found in severe septicæmic forms of diphtheria an increase of leucocytes, increasing and diminishing with the severity of the process. The mild cases showed no leucocytosis, which fact, according to these authors, has a prognostic value. Von Limbeck found always a marked leucocytosis, and it was greatest in the severest cases.

**PNEUMONIA.**—The leucocytosis is generally very marked, coming on from six to twelve hours before the physical signs of pneumonia show themselves, and in the same way the temperature crisis of the pneumonia is sometimes preceded by a crisis in the number of the leucocytes of about the same length of time. This, of course, is of value in prognosis. There have been some cases recorded (generally fatal ones) in which the leucocytosis did not occur. This may possibly have been dependent upon the nature of the infection. Von Limbeck’s experiments upon dogs seem to show that Friedländer’s bacillus caused a marked leucocytosis, whereas Fraenkel’s diplococcus caused scarcely any. The leucocytosis is said to be higher in children than in adults in pneumonia.

Here in this next bed (Case 132) is an infant eight months old with the characteristic clinical symptoms and physical signs of a fibrinous pneumonia, involving the whole of the left lower lobe of the lung. As the case is one of undoubted pneumonia without complications, the blood examination which has just been made is of unusual interest:

BLOOD EXAMINATION 17. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,813,750
Hæmoglobin . . . . .	54 per cent.
Leucocytes . . . . .	40,000
Small mononuclear . . . . .	51 per cent.
Large “ . . . . .	21 “
Polynuclear . . . . .	27 “
Eosinophiles . . . . .	1 “

The small percentage of the polynuclear cells is very unusual in a case of this kind. They are generally much increased, and their small percentage, though partially accounted for by the age of the infant, cannot be entirely explained in this way.

The next case that I have to show you (Case 133) is also one of pure fibrinous pneu-

monia, in a boy three and one-half years old. Three examinations of the blood have been made in this case. The first one was made eighteen hours after the crisis had occurred, the second one forty-five hours after the crisis, and the third one has just been made to-day, which is the tenth day since the crisis occurred.

BLOOD EXAMINATION 18. (Whitney and Wentworth.)  
(*After crisis.*)

	I. 18 hours.	II. 45 hours.	III. 10 days.
Erythrocytes . .	4,598,750	4,849,166	About the same as before.
Hæmoglobin . .	52 per cent.	53 per cent.	Not taken.
Leucocytes . .	24,500	29,000	17,500
Small mononuclear . . . .	28 per cent.		21 per cent.
Large " . . . .	18 "		11 "
Polynuclear . . . . .	51 "		68 "
Eosinophiles . . . . .	3 "		

At the time that the second examination was made the temperature was normal. The percentage of polynuclear cells in this case would be very small if the patient were an adult, but for a child of this age they show, as would be expected, a moderate increase. To-day, with a normal temperature and with resolution completed, we find, as we should expect, a decided lessening of the leucocytosis. Dr. Cabot's observations have convinced him that the so-called blood crisis occurs in only a certain percentage of cases of pneumonia, and that a blood lysis is more common.

**BRONCHO-PNEUMONIA.**—The next case (Case 134) is one of broncho-pneumonia occurring in a rhachitic child four years old.

BLOOD EXAMINATION 19. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,286,250
Hæmoglobin . . . . .	53 per cent.
Leucocytes . . . . .	54,000
Small mononuclear . . . . .	18 per cent.
Large " . . . . .	11 "
Polynuclear . . . . .	71 "

The pneumonia was marked by certain circumscribed patches of dulness in both backs. It ran the usual course of broncho-pneumonia, and resulted in complete recovery.

**PNEUMONIA AND EMPYEMA.**—The next case (Case 135) is that of a boy thirteen years old, who has had a marked fibrinous pneumonia running its usual course, and now has an empyema as a complication. He has been aspirated, and streptococci were found in the pus. The result of the blood examination is very significant.

BLOOD EXAMINATION 20. (Whitney and Wentworth.)

Erythrocytes . . . . .	3,513,750
Hæmoglobin . . . . .	43 per cent.
Leucocytes . . . . .	45,000
Small mononuclear . . . . .	8 per cent.
Large " . . . . .	5 "
Polynuclear . . . . .	86 "
Eosinophiles . . . . .	1 "

On comparing this case with the two cases of fibrinous pneumonia which I have just shown you, you will note how much larger the percentage of polynuclear cells is than where the pneumonia was uncomplicated.

**EMPYEMA.**—This next case (Case 136), a boy twenty months old, is one of empyema. The blood examination was made yesterday.



## BLOOD EXAMINATION 21. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,393,750
Hæmoglobin . . . . .	49 per cent.
Leucocytes . . . . .	28,000
Small mononuclear . . . . .	9 per cent.
Large " . . . . .	16 "
Polynuclear . . . . .	74 "
Eosinophiles . . . . .	1 "

(This infant had the radical operation for empyema performed on it, and ultimately recovered completely.)

Here in this next bed is another case of empyema (Case 137), ten years old, in which the blood count was made this morning.

## BLOOD EXAMINATION 22. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,355,000
Hæmoglobin . . . . .	60 per cent.
Leucocytes . . . . .	66,000
Small mononuclear . . . . .	7 per cent.
Large " . . . . .	8 "
Polynuclear . . . . .	85 "

(This child was operated upon and recovered completely.)

**MILIARY TUBERCULOSIS.**—You will remember the male infant twenty-five months old (Case 138) which I examined before you in the ward yesterday, and in which there was a question whether it was a case of simple starvation or one of general miliary tuberculosis with some complication. The blood examination resulted as follows:

## BLOOD EXAMINATION 23. (Whitney and Wentworth.)

Erythrocytes . . . . .	5,567,500
Hæmoglobin . . . . .	66 per cent.
Leucocytes . . . . .	29,500

The autopsy this morning showed a general miliary tuberculosis of all the organs, and an absence of pneumonia.

Miliary tuberculosis in adults shows no leucocytosis, and the increase of the leucocytes in this case is but moderate, and might be due entirely to starvation.

**TUBERCULAR MENINGITIS.**—Here is an interesting case of cerebral disease (Case 139) in a male infant. The clinical symptoms and general aspect of the child are those of tubercular meningitis. The blood examination, however, shows that some complication is in all probability present.

## BLOOD EXAMINATION 24. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,541,250
Hæmoglobin . . . . .	68 per cent.
Leucocytes . . . . .	38,000
Small mononuclear . . . . .	22 per cent.
Large " . . . . .	20 "
Polynuclear . . . . .	58 "

In considering this case I must remind you that the bacillus of tuberculosis is not a pyogenic organism. As I can find no lesion in any of the organs to account for the increase in the leucocytes, a large proportion of which are polynuclear neutrophiles, we

must suppose that the original miliary inflammation was followed by a secondary infection of some pus-producing organism.

(The infant passed through the various typical stages of tubercular meningitis and died. No autopsy was obtained.)

The statement that the leucocytosis which is at times found in tubercular meningitis depends on some complication is well illustrated in the case (Case 140) of the little girl eleven years old who was shown to you a few days ago as a case of tubercular meningitis. The clinical symptoms were very typical from the beginning to the end of the disease, but the blood examination, as I explained to you at that time, led me to believe that some complication was present.

#### BLOOD EXAMINATION 25. (Wentworth.)

Erythrocytes . . . . .	5,298,750
Hæmoglobin . . . . .	68 per cent.
Leucocytes . . . . .	37,500

The autopsy showed the case to be one of tubercular meningitis, represented by solitary tubercles in the brain without any purulent exudation. There was, however, found in the abdomen an appendicitis, which accounted for the leucocytosis.

**HYDROCEPHALUS.**—This little girl (Case 141), six years old, is a marked case of hydrocephalus. The history of the noticeable enlargement of the head corresponds to the general hydrocephalic appearance of the child.

CASE 141.



In the result of the blood examination of this case I cannot explain the high percentage of the polynuclear cells.

#### BLOOD EXAMINATION 26. (Whitney and Wentworth.)

Erythrocytes . . . . .	5,675,000
Hæmoglobin . . . . .	80 per cent.
Leucocytes . . . . .	19,000
Small mononuclear . . . . .	4 per cent.
Large " . . . . .	8 "
Polynuclear . . . . .	83 "
Eosinophiles . . . . .	5 "

This next case (Case 142), a boy two years and ten months old, is apparently also one of hydrocephalus, but of slight degree. The blood examination resulted as follows:

BLOOD EXAMINATION 27. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,492,500
Hæmoglobin . . . . .	72 per cent.
Leucocytes . . . . .	20,500
Small mononuclear . . . . .	20 per cent.
Large " . . . . .	20 "
Polynuclear . . . . .	58 "
Eosinophiles . . . . .	2 "

The cause of this leucocytosis is not known. The examination of the lungs and the heart was negative; the head measured twenty-six inches; there was protrusion of the eyes, as well as mental disturbance. The child remained in the hospital, and showed continued improvement until complete recovery some months later.

**CHOREA.**—I shall now show you a case (Case 143) of chorea of a severe type, but without complications. The child, a boy eight years of age, can scarcely swallow, and is unable to speak, stand, or walk. The choreiform movements are, as you see, constant. The result of the blood examination is as follows:

BLOOD EXAMINATION 28. (Wentworth.)

Erythrocytes . . . . .	5,222,500
Hæmoglobin . . . . .	60 per cent.
Leucocytes . . . . .	19,000

There has at times been a faint hæmic murmur over the base of the heart, but this has been very transient and has now passed away.

**NEPHRITIS.**—I have here to show you two cases (Cases 144, 145) of renal disease. The examinations of blood made in renal disease in children have not been very extensive or satisfactory, but in general the specific gravity of the blood is quite low, on account of the loss of albumin in the blood serum. The specific gravity of the serum is much diminished, 1022 to 1023. Klein, in a series of observations upon the blood in the nephritis of scarlet fever, has found an increase of eosinophiles in favorable cases, and an absence of them in fatal cases.

**ACUTE NEPHRITIS.**—This first case (Case 144), a boy six years old, was one of acute nephritis. The urine at present, however, only shows an active hyperæmia of the kidney. The blood examination gives the following results:

BLOOD EXAMINATION 29. (Whitney and Wentworth.)

Erythrocytes . . . . .	3,481,250
Hæmoglobin . . . . .	51 per cent.
Leucocytes . . . . .	32,500
Small mononuclear . . . . .	8 per cent.
Large " . . . . .	10 "
Polynuclear . . . . .	80 "
Eosinophiles . . . . .	2 "

The percentage of the eosinophiles, you see, is no greater than normal, although the case seems to be tending towards recovery.

**CHRONIC NEPHRITIS.**—The other case (Case 145), a girl nine and one-half years old, is one of chronic parenchymatous nephritis.

BLOOD EXAMINATION 30. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,355,000
Hæmoglobin . . . . .	60 per cent.
Leucocytes . . . . .	33,000
Small mononuclear . . . . .	36 per cent.
Large " . . . . .	4 "
Polynuclear . . . . .	60 "



Unfortunately, the percentage of eosinophiles in this case was not recorded. The size of the leucocyte count is remarkable.

**TUBERCULAR PERITONITIS.**—I have here two cases of tubercular peritonitis, in which the diagnosis has been verified by laparotomy. The blood examinations were made before the operations were performed.

The first case (Case 146) was one of an infant eighteen months old, and the blood examination resulted as follows :

BLOOD EXAMINATION 31. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,970,000
Hæmoglobin . . . . .	48 per cent.
Leucocytes . . . . .	19,000
Small mononuclear . . . . .	19 per cent.
Large       " . . . . .	18   "
Polynuclear . . . . .	73   "

This case, as well as the first one, followed the rule of an absence of leucocytosis in tuberculosis, for at this age the leucocyte count may be as high as 19,000 to 20,000 under physiological conditions.

The second case (Case 147) is a boy nine years old.

BLOOD EXAMINATION 32. (Whitney and Wentworth.)

Erythrocytes . . . . .	4,792,500
Hæmoglobin . . . . .	55 per cent.
Leucocytes . . . . .	7,500
Small mononuclear . . . . .	18 per cent.
Large       " . . . . .	31   "
Polynuclear . . . . .	54   "

**INFANTILE ATROPHY.**—The next case (Case 148), eleven months old, is one of infantile atrophy. The extreme emaciation of this infant is well seen in looking at its

CASE 148.



Infantile atrophy. Female, 11 months old.

back, where there is an almost entire absence of adipose tissue, so that the vertebræ and the ribs can be studied as though on the dissected skeleton.

The result of the blood examination in this case is as follows:

BLOOD EXAMINATION 33. (Wentworth.)

Erythrocytes . . . . .	4,738,750
Hæmoglobin . . . . .	76 per cent.
Leucocytes . . . . .	21,000

This count was made after the infant had been under treatment for over three and a half months, so that we cannot take it as typical of the early stages of the disease.

Guffer found a gradual diminution of erythrocytes and an increase in leucocytes in these cases of infantile atrophy, which he referred to the accompanying anæmia. Parrot found that a diminution of red corpuscles constantly went on until death, and that the increase in the leucocytes corresponded to the severity of the disease. Schiff made some experiments proving the analogy between these cases with loss of fluid and cases in which fluids were withheld, both causing concentration of the blood.

**PERIOSTITIS.**—In order to show you of what great importance a careful examination of the blood may be in determining the diagnosis in obscure cases, I will report to you the following case (Case 149):

CASE 149.



Female infant, 15 months old. Periostitis of both legs.

Many of you will remember seeing the infant at the Children's Hospital, where it was brought to be treated for a persistent and painful swelling of the right thigh. It was at that time fifteen months old, and the pain had been so severe that it had lost much

sleep. The right thigh was swollen to nearly twice the size of the left one, and was very tense,—in fact, so much so that the outline of the bone could not be distinguished. The suffering of the infant was so great that it was transferred to the Infants' Hospital, where it came under the surgical care of Dr. Lovett. For the purpose of diagnosis an incision was made on the outer side of the right thigh. On reaching the bone, it was found to be covered with a layer of grayish, friable tissue, at least a quarter of an inch in thickness. The aspect of the growth was that of a malignant tumor, and this appearance was so striking that a small bit was removed and referred to a pathologist for examination. The report from this examination was that the growth removed was not large enough for a positive diagnosis, but that it simulated very closely an osteo-sarcoma. A few days later another incision was made in the right tibia, which can be seen in this photograph taken immediately after the operation.

Another piece of the growth was removed, and on examination was reported by the pathologist to be probably an osteo-sarcoma. The infant had been in the hospital for about ten days, and the swelling had steadily increased, while its general condition had become worse. The question of amputation was considered, but at this time a blood count was made, which so strongly pointed toward the absence of a malignant growth that it was considered wiser to postpone the operation and wait for further developments.

#### BLOOD EXAMINATION 34. (Whitney.)

##### Leucocytes.

Small mononuclear . . . . .	46 per cent.
Large " . . . . .	18 "
Polynuclear . . . . .	36 "

The significance of this differentiation of the leucocytes lay in the small percentage of the polynuclear variety, which should have been found increased if the disease of the bone had been a new growth, such as is represented by osteo-sarcoma. Somewhat later, but before the blood examination had been finished, the left thigh was also incised, owing to a suspicion of trouble in that location, and a piece of periosteum covering the left femur was removed. This was also reported as a probable osteo-sarcoma, and the infant was discharged from the hospital as a hopeless case, and was taken home to die. The subsequent history of this case is of extreme interest, in reference to the value of blood examinations, for the infant soon began to improve, the swelling was absorbed, and, although the infant was late in walking, it is now, after an interval of some months, well and strong, and presents no appearance of disability in the legs. The growth was probably a sluggish periostitis of an unusual type, which simulated sarcoma very closely. The case is a unique one.

**SCORBUTUS.**—Nothing distinctive has as yet been found in the blood examinations which have been made in cases of infantile scorbutus.

**ICTERUS NEONATORUM.**—The simple benign form of icterus neonatorum, which I have described to you in an earlier lecture, is practically a physiological condition. Up to the present time there have not been found any pathological changes in the blood.

**SCLEREMA NEONATORUM.**—In the beginning of sclerema neonatorum there is no especial change in the blood until the tissues have been drained of their fluid. In protracted cases, however, through diminution of the hæmoglobin, caused by insufficient fluid, a gradual sinking may occur in the specific gravity of the blood without any change in the serum.



## LECTURE XVII.

## PARASITES OF THE BLOOD.—LITERATURE OF THE BLOOD IN EARLY LIFE.

As in other parts of the economy, so in the blood are found parasites, which may be of the vegetable or of the animal kingdom.

Of the vegetable parasites, such as (1) Moulds, (2) Yeasts (*Saccharomycetes*), and (3) Fission-fungi (*Schizomycetes*, *Bacteria*), the latter (Fission-fungi) are the only ones which would be likely to occur in the blood of early life, and even they do not especially concern us in our discussion of the blood.

Of the animal parasites (*Hæmatozoa*) we find two classes, (1) Protozoa and (2) Vermes. The former class (Protozoa) is the only one with which I have had any experience, and I shall therefore confine my remarks to the micro-organisms of malaria.

**MALARIA.**—The term malaria should be limited to a definite disease in which we know there is a specific infectious origin. This specific infection is primarily shown in the blood in the form of certain micro-organisms which, like the *amœba coli*, belong to the class of protozoa, and inhabit the blood of the infected individual. We must, however, understand that in the specific micro-organisms of malaria we have not as yet proved the three conditions required to show that a given disease is caused by a specific micro-organism. These three conditions, as formulated by Koch, are as follows :

(1) The presence of the organisms in all cases of the disease and in such distribution as will explain the lesions.

(2) The isolation of the organism in pure culture.

(3) The reproduction of the disease by inoculation with the isolated organisms.

When, as has been said by Welch, all these conditions have been fulfilled, there will be no doubt that the disease has been caused by the especial organism. In regard to malaria, therefore, you see that only the first of Koch's three required conditions is present. The micro-organism of malaria has not been found in any other part of the body than the blood, and malaria may therefore justly be said to be a disease of the blood. It has no known means of exit from the body, and its mode of entrance has not been definitely determined. The germs of this parasite may be contained in the blood-plasma, or in the substance of the erythrocytes. The name plasmodium has been given to the germ found in the red blood-disks. According to Thompson, in acute paludism (malarial fever) the plasmodium

is found in the form of amœboid bodies, occupying a place in a certain number of the erythrocytes or adhering to them. These bodies derive pigment (melanin) from the erythrocytes, and, after undergoing a certain degree of development, increase in size at the expense of the erythrocytes. They are found to contain this pigment in distinct granules and rods. They vary in size, and some are as large as the erythrocytes. They are at first colorless and transparent, and at the height of their development they undergo segmentation. This amœboid form of the parasite is the one commonly found in what is designated as the tertian variety of malaria, and is the most common of all the known forms of the parasite of malaria.

In addition to these amœboid forms, crescentic shapes of the germ, according to the investigations of Laveran, are common in the blood of certain types of paludism, irregular forms of the disease, and malarial cachexia. Like the amœboid forms, they are transparent and colorless, except for the pigment-granules which they contain in their centres. They are larger than the amœboid forms, are much more rare, and are much less affected by the action of quinine.

Councilman describes flagellate bodies as being most commonly found in blood which has been aspirated from the spleen; and in acute cases of malaria they may sometimes appear in other situations. They exhibit from three to eight vibrating cilia.

It is still a matter of dispute whether the plasmodium malarie is polymorphous and thus may produce the different types of malaria, of which I shall presently speak, or whether there are certain distinctly separate organisms to which the name plasmodium malarie is applied.

There is no doubt that two distinct forms of parasites of malaria can be diagnosticated by the appearance of the plasmodium in the blood, and that these two forms can be separated clinically.

Golgi is the investigator who has most clearly shown that there is more than one parasite of malaria, while Laveran is the exponent of the polymorphous theory.

METHOD OF EXAMINATION.—The technique of the examination of the blood for the purpose of detecting the plasmodium malarie is very simple. I shall describe the method which has been used more largely for children than any other, and which has been found satisfactory by Dr. Koplik, of New York, whose work on the blood of malaria in early life is more extensive than that of any other investigator up to the present time.

The blood is first examined in a fresh condition by placing a drop on a slide, covering it with a cover-glass, and studying it under a microscope without a heated stage. Another specimen of blood is spread rapidly on a dozen or eighteen cover-slips by Ehrlich's method. The blood is then allowed to dry in the air, protected from dust. It is then placed on the Ehrlich brass plate and heated for an hour or an hour and a half. The



cover-glasses are then stained in a very dilute solution of methylene-blue. Eosin is not used, as some varieties decolorize the blue and thus introduce an element of uncertainty. The blood is heated at a temperature above the boiling-point ( $120^{\circ}$  C.) on the plate. The variety of dye is important, as some blue does not stain. Grüber's blue powder, soluble in alcohol, has proved to be satisfactory. A few drops of the saturated solution of this blue in alcohol are added to 30 c.c. (1 ounce) of water. The cover-glasses should not be deeply stained, as certain appearances may, under these circumstances, be lost. They are to be repeatedly washed in water and then dried in the air without heating, as heat decolorizes them. In this way the blood-cell is well hardened, and its protoplasm and hæmoglobin stain more certainly than when hardened with alcohol, sublimate, or osmic acid. Other specimens, again, may be stained by Ehrlich's aniline method to study the different appearances. The erythrocytes of malarial cases, when stained in this way, show the plasmodium in blue and the protoplasm in yellowish green or colorless rings, if there is anæmia. If the Ehrlich dyes are used, aurantia, orange G, and others (preferably the solution in glycerin of eosin, indulin, and aurantia), the plasmodium does not stain, but the hæmoglobin of the erythrocytes is stained in shades of varying intensity.

As in every case of pronounced malaria, whether in early life or in adults, the characteristic feature of the disease is a paroxysm, we naturally should first examine the blood at a time when this paroxysm is taking place, and from this point study the changes which the parasite shows in the intervals between the paroxysms.

Golgi was the first observer who actually described and differentiated the more common forms of paludism, and his observations coincide practically with those which have been made since. I shall, therefore, describe, as observed by Golgi, the main features of the changes in the blood which are caused by the development of the plasmodium, and such features as will explain the resulting symptoms of malaria and will thus be of clinical importance. These changes in the plasmodium have been so well described by Dr. Thayer, of Baltimore, that I shall quote what has been said by this admirable investigator. It will, however, be necessary first to explain certain terms which, having been used in connection with malaria, and having become established before the specific parasite of malaria was known, are really more adapted to the symptoms of the disease, and are hence given more prominence than is in accordance with our present knowledge of it.

The prominent symptom of malaria being the paroxysm, earlier authors naturally classified malaria according to the time when the paroxysms appeared, using the term quotidian where they occurred with intervals of twenty-four hours, tertian where they occurred with intervals of forty-eight hours, and quartan where they occurred with intervals of seventy-two hours. The term tertian is somewhat misleading, unless we understand



that it is a word derived from the Latin method of counting the day of the beginning of the febrile manifestation as the first day. The terms tertian and quartan, therefore, are simply used empirically to represent intervals of forty-eight and of seventy-two hours between the paroxysms. Again, the terms intermittent and remittent have been used commonly. The *intermittent* form is characterized by entire absence of fever between the paroxysms. The *remittent* form is characterized by the presence of more or less fever of a continued type which does not cease between the paroxysms. You will presently see that these terms should not be used as classifications of distinct types of malaria, as the conditions which they represent may, according to chance, appear in any of the types, and are merely caused by a variation in the behavior of the parasite.

If we examine the blood from a tertian case where there is a decided interval of twenty-four hours between the paroxysms, we find that just after the paroxysm some of the erythrocytes will contain small, round, colorless bodies, which appear to have a slight depression in the centre, and when stained in dry specimens show a pale central area with a dark periphery.

"These bodies, examined in the fresh specimen, show active amœboid movements. A few hours later the organism will be found to have increased somewhat in size and to contain a few fine brownish pigment-granules which dance actively under the eye, the motion probably being due to undulating movements in the protoplasm. On the day between the paroxysms the bodies will be found to have half filled the erythrocytes. They are still actively amœboid, and the number of pigment-granules is considerably increased. The erythrocyte at this stage will be seen to be a trifle larger than its unaffected neighbors, and to be considerably decolorized. On the day of the paroxysm the organism is found to have entirely filled and almost to have destroyed the erythrocyte, which is represented only by a faint pale rim about the full-grown parasite, if indeed it has not entirely disappeared. The pigment-granules may show at this stage a very active motion, but the amœboid movements of the organism, as a whole, are but little marked. At the time of the paroxysm a change takes place. The pigment gathers together in a more or less solid clump, usually in the centre of the erythrocyte, while the rest of the protoplasm looks somewhat granular, and shows a suggestion of lines radiating outward from the centre. This appearance gradually changes, the lines becoming more distinct, until finally we see the central clump of pigment surrounded by from fifteen to twenty small, ovoid or round glistening segments, each one having a central more refractive spot, and resembling strongly the hyaline bodies which we see immediately following the chill. This segmentation of the organism is always coincident with the paroxysm, and the presence in the blood of a segmenting body is a sure indication that the paroxysm is present or is about to occur. Immediately following the paroxysm fresh hyaline bodies appear in the erythrocytes. Though the invasion of the corpuscles

by these fresh segments has never been actually observed, the evidence that this occurs is so strong that we can safely accept it as a fact. Besides these forms, we see not infrequently small or large extra-cellular pigment bodies,—that is, organisms resembling exactly those within the erythrocytes, except that they are free in the blood-current. These may be seen at times to break up into several smaller bodies, while at other times they may show a long tail-like non-motile process containing sometimes a few pigment-granules. They are probably organisms which have escaped from the erythrocytes, or full-grown bodies which have broken up. They are considered to be a degenerative form."

At times we find the flagellate bodies which I have already referred to as described by Councilman.

According to Thayer, the characteristics of this form of organism, which is observed in tertian fever alone, are so marked that with a little study of the parasites one can make a definite diagnosis of the type of fever from an examination of the blood alone. He also observes that the quartan fever is not common in this country, but that where he has seen it the organisms differ distinctly from the tertian parasite, and their appearance coincides exactly with that described by Golgi. For instance, the first stage of the quartan organism is similar to that observed in the tertian, except that the amœboid movements are not so active; as the body develops the rods and clumps of pigment are larger and darker than those which appear in the tertian form, while the amœboid movement of the organism is relatively slight. The full-grown quartan forms are materially smaller than those found in the tertian, while the erythrocytes, instead of being expanded and decolorized, appear at times shrunken about the body and of a somewhat deeper old-brass color (Messingfarber). Thayer also states that in the quartan form the segmentation of the organism is into from six to ten different parts, instead of from twenty to thirty, as is seen in the tertian form.

Although Marehifava and Celli have described an organism which they assert causes a definite form of paludism represented by the paroxysm occurring at intervals of twenty-four hours, this has not been corroborated by other investigators. We are not justified, therefore, in assuming that there is an especial parasite which causes a distinct disease represented by the term quotidian. In like manner, we do not at present recognize that there is a separate parasite which may cause the symptoms of remittent fever, unless it shall be proved to be the æstivo-autumnal. I shall therefore confine my remarks to the two forms of disease represented by intervals in the paroxysms of forty-eight hours and seventy-two hours.

It is evident from what I have already told you concerning the changes which the plasmodium malarie undergoes in the process of its development in the erythrocytes that it causes the different symptoms which arise in malaria by its action in the different stages of its development. We see also that the segmentation of the organism is always coincident with the



paroxysms, and that the interval between the paroxysms is characterized by a distinct and early stage of development of the parasites.

Koplik has made so especial a study of malaria as it appears in early life that I shall quote freely from his writings on this subject.

In pure types of paludism, either tertian or quartan, one generation of the plasmodium will be found to predominate. In those cases of tertian where the paroxysms are found to be of daily occurrence, several generations of parasites, each with a different cycle of development, will be found in the blood. The same observation will be found to be true where irregular types of fever with the tertian parasite are carefully examined, and also where the blood in quartan fevers is examined. If more than one generation of parasites exists in the blood in a tertian case, the fever may become quotidian, with daily paroxysms due to the ripening of distinct sets of parasites on different days, each set of parasites taking forty-eight hours to mature. In like manner, in cases of quartan fever, through the ripening of distinct sets of parasites on different days, different combinations occur, according to the number of sets of parasites. Thus, while in the form in which there is only one parasite the intervals between the paroxysms are seventy-two hours, in that in which there are two parasites there may be an interval between the paroxysms of only forty-eight hours, and where there are three parasites there may be an interval of only twenty-four hours, thus representing the quotidian chills described by Mannaberg. This will be more clear to you if you examine this table (Table 88), which I have arranged for the purpose of definitely explaining the different types of paludism as they are now understood by the most recent investigators.

TABLE 88.

*The Principal Combinations of Paroxysms caused by the Plasmodium Malarix.*

	Intervals.	1st day.	2d day.	3d day.	4th day.
TERTIAN.					
Pure tertian . . . . . (One parasite.)	48 hours.	Paroxysm.	No paroxysm.	Paroxysm.	No paroxysm.
Double tertian . . . . . (Two parasites. Quotidian.)	24 hours.	Paroxysm.	Paroxysm.	Paroxysm.	Paroxysm.
QUARTAN.					
Pure quartan . . . . . (One parasite.)	72 hours.	Paroxysm.	No paroxysm.	No paroxysm.	Paroxysm.
Double quartan . . . . . (Two parasites.)	48 hours.	Paroxysm.	Paroxysm.	No paroxysm.	Paroxysm.
Triple quartan . . . . . (Three parasites. Quotidian.)	24 hours.	Paroxysm.	Paroxysm.	Paroxysm.	Paroxysm.

The table, as you see, explains how the different intervals in the paroxysms are caused by the development of the parasite on different days. It will therefore be easy for you to understand that it is according as the parasite happens to develop that we have a regular or an irregular periodicity.



Thus, it may happen that we have two parasites, and these two parasites may develop on the same day, but at different hours. In this case, supposing that they are of the tertian type, two paroxysms may occur on the same day, followed by an interval of forty-eight hours from the time of the full development of each of the parasites until this development occurs again. In this way different broods of parasites may cause an almost infinite variety of symptoms. Again, we must recognize that it is probably true that it is only when the broods of the parasites are especially large in number that a pronounced paroxysm is produced, because if the brood is small in number and insignificant it may cause only a greater or less rise of temperature in place of a pronounced paroxysm. You see that in this way we can probably explain those different forms which have been designated as remittent fever. That is, on the intervening day, when there is no paroxysm, but only a continuous heightening of temperature, it may be that the broods have developed only sufficiently to produce fever and not a paroxysm, and we shall probably in the future, by a more extended study of this parasite in all its phases and under all circumstances, be able to show that it is a variation in numbers as well as in the kind of the parasite which causes these distinct differences in the symptoms of malaria.

It has been noticed that the administration of quinine tends to interfere with the regularity of the time of the paroxysm, and in this way other variations may occur. It has also been noticed that if the paroxysm comes earlier in the day than it has been doing, the disease is apt to be of a severe type and to be growing worse, while if the interval is lengthened and the attack is found to come at a later hour in the day than usual, it is a sign that the disease is amenable to treatment, is of a benign character, and is tending towards recovery.

The tertian form is the one which is by far the most common in this country, and the one which is most influenced by the administration of quinine, the other form, represented by the quartan, being peculiarly difficult to manage with quinine. In young infants the tertian form in its quotidian variety is met with most commonly. In older children, in my experience, it is the pure tertian that is most common. It will be noticed, by glancing at the table (Table 88, page 385), that the quartan form of paludism can never represent by its intervals and paroxysms the pure tertian form.

**PATHOLOGY.**—There are no especial differences between the pathological lesions found in the malaria of children and those which occur in adults. I shall, therefore, not dwell on this part of the subject, but shall merely state what Thayer has said concerning this disease.

In *acute* cases of malarial fever, on examination with the microscope, the *cerebral* capillaries are found to be crowded with malarial parasites. There is usually a marked granular degeneration of the endothelium of the vessels.

The *spleen* is always enlarged. The capsule is tense. The parenchyma is cyanotic, of a slaty-gray color, and almost diffuent. The pulp of the

spleen is found to contain enormous numbers of red blood-corpuscles, many of which contain parasites. It also contains numerous large white elements rich in protoplasm, with usually a single bladder-like nucleus and at times coarse granulations. These elements are commonly laden with pigment, which at times has the same arrangement as it has in the body of the parasite itself. There may be free pigmentation in the intercellular spaces of the pulp. The small mononuclear elements and the lymphocytes of the follicles never contain pigment. The capillaries are usually filled with the plasmodia, while the splenic veins show relatively few, though they always contain large cells enclosing pigment or the remains of red blood-corpuscles.

The *liver* has usually a slaty-gray color. The capillaries are filled with leucocytes, which contain numerous pigmented bodies. Relatively few plasmodia are found in the blood-corpuscles in the vessels.

The *lungs* show in their capillaries numerous cells containing pigment clumps and well-preserved parasites, although it is unusual to find pigment in the endothelial cells, in the capillaries, and in the smaller veins.

In the areas of broncho-pneumonia which may occur, polynuclear leucocytes are often found, while the large pigmented cells take no part apparently in the active inflammatory process.

The vessels of the *kidneys* contain relatively few organisms. The glomeruli may be considerably pigmented. There may be marked degeneration of the epithelium of the capsule, and at times changes in the parenchyma, especially areas of necrosis of the epithelium of the convoluted tubules. The other *viscera* show no special characteristic changes, except, at times, that of melanosis.

In the more *chronic* form of malaria the *anæmia* is usually particularly marked. The *spleen* is always enlarged and very firm. There is marked thickening of the capsule, which is often adherent to the neighboring tissue. On section the spleen is generally of a dark brownish-gray color, the fibrous tissue throughout the organ being greatly thickened. The *liver* is considerably enlarged, and usually has a grayish-brown or slaty color. At times there is a considerable increase in the connective tissue. The *kidneys* show no particularly characteristic changes, though there may be considerable pigmentation. The pigment is most marked about the blood-vessels and the Malpighian bodies, and sometimes in the region of the convoluted tubules.

There are no characteristic changes in the other *organs*, except the slaty-grayish pigmentation.

DIAGNOSIS.—Malaria as it occurs in early life is far more difficult to diagnosticate by its symptoms than where the disease runs the typical course usually seen in the adult. It is the most protean disease which we are called upon to deal with in young children, and it simulates so closely almost every other disease we are likely to meet with that we should always be on our guard, and allow the possibility of the existence of the plasmodium malarie



in making a diagnosis in a doubtful case where a periodicity is noticed in the symptoms.

The only rational method of determining that we are dealing with a case of malaria is the examination of the blood, which at once settles the question if the plasmodium be found.

**SYMPTOMS.**—The symptoms of malaria as it occurs in infants and in young children are much more varied and far more uncertain than those which we are accustomed to meet with in adults.

The younger the individual the more likely are the pronounced chills to be replaced by some other symptom, such as vomiting, delirium, and convulsions. The paroxysms come more frequently in children than in adults, and in young children a condition of apathy and somnolence, sometimes with fever, and sometimes accompanied by coldness of the extremities and a collapsed condition, very commonly replaces the chill of the adult. These symptoms, representing the onset of the disease, may often disappear as the disease becomes established, and in their place we may meet with the symptoms of some other disease, such as bronchitis, torticollis, and many other affections. The symptoms of these other diseases will often continue and be very intractable until quinine is given, when they will disappear, and thus we shall be led to believe that we have been dealing with one of the masked and misleading manifestations of the plasmodium malariae. (Vide Case 269, page 610.)

My experience with malaria in young children is so similar to that of Dr. Holt, of New York, who has written more fully on the symptoms of malaria in early life than any one else of whom I know, that I shall quote from his writings on this subject.

The susceptibility of the nervous and respiratory systems in young children to produce variations in the form and type of malaria is most misleading in regard to diagnosis, the symptoms referable to a particular organ often completely overshadowing the real disease, malaria, and producing an entirely new clinical picture. The symptoms often are so indefinite and the disease frequently comes on so insidiously that the physician does not see the case until it has made considerable progress and the diagnosis thus is much obscured.

In addition to the other symptoms of which I have already spoken, severe pain in the head and sometimes in the epigastric region is met with. In the form in which the invasion is gradual, the prominent symptoms are anæmia, loss of appetite, and frontal headache of moderate type. The spleen in the majority of cases is found to be enlarged, but the well-known difficulty of detecting an enlarged spleen in young children makes it possible that in many cases there is enlargement of the spleen without our being able to detect such enlargement by percussion or palpation.

The time and character of the onset of the disease and of its paroxysms are very irregular, so much so, indeed, that it would not be practicable to dwell upon the exact differences which occur from those in the adult.



Splenic and hepatic tenderness, and pains in the back, extremities, and neck, are occasionally observed, and general cutaneous hyperæsthesia is at times noticed. As the capsule of the spleen is less resistant in young children than in adults, the organ seems to enlarge more rapidly, and also to subside more quickly, in children than in adults.

The condition of the intestinal tract varies as much as do the other symptoms. Sometimes constipation is present, and sometimes diarrhœa, the latter being the more prominent the younger the child.

Dr. Holt's observations on the pulmonary symptoms occurring during attacks of malaria are so interesting and important that they should be recorded. Bronchitis was found to be the most frequent of all the complications occurring in the course of malaria, and again and again proved to be intractable until its malarial origin was discovered. Certain acute cases appeared to be pulmonary congestions analogous in their pathology to the congestions of the spleen and the liver. The pulmonary symptoms in these cases were quite uniform and characteristic. The invasion was acute and the temperature high, ranging from 40° C. to 41.1° C. (104° to 106° F.). The respirations were very rapid, in three or four cases reaching 100 in a minute, and resembling the superficial breathing of lobar rather than the labored breathing of lobular pneumonia. The face was often cyanotic, and the pulse varied from 160 to 200 per minute. In one or two cases there was marked drowsiness. The physical signs were usually a slight increase of vocal fremitus and slight dulness on percussion. The respirations were always high-pitched and sometimes broncho-vesicular. Vocal resonance was exaggerated, and there were sonorous râles and occasionally coarse and fine mucous râles. These signs were sometimes general in both lungs, but were usually most marked behind and towards the apices. They were at times found to be confined to a single lung and once to a single lobe. When first seen they were diagnosticated as cases of pneumonia, but their subsequent progress and termination convinced Dr. Holt that they were temporary manifestations of malaria, for patients who were seen in the afternoon with these symptoms would be found the following morning running about the house with a normal pulse and respiration, and with only the signs of an insignificant bronchial catarrh in the chest. These attacks would recur on the following days until quinine was administered. Marked splenic enlargement was detected in these cases.

Pneumonia, both lobar and lobular, was occasionally found as a complication of malaria.

Spasmodic asthma of malarial origin was seen in some cases. These attacks were accompanied frequently by marked splenic enlargement, and were promptly relieved by antiperiodics.

PROGNOSIS.—The prognosis of malaria in children is good, provided that the child is removed from the malarial district and is treated with quinine. Relapses occur, even after long intervals of apparent immunity, and the disease can recur a number of times.

When a child has been once attacked by the plasmodium malariae, it seems to be peculiarly vulnerable to a second attack of the organism.

TREATMENT.—Quinine is the only drug which can be relied upon to eradicate the plasmodium malariae from the blood, and is the only medicine for this purpose which I shall mention.

It may be given to an infant under six months in doses of 0.03 gramme ( $\frac{1}{2}$  grain); at one year the dose may be 0.06 gramme (1 grain), at two years it may be 0.12 gramme (2 grains), and it can be increased up to 0.3 or 0.36 gramme (5 to 6 grains) at five and six years. There is little danger of giving too large doses of quinine to children, as they tolerate the drug very well. The latest investigations have shown that the plasmodium is most sensitive to the action of quinine when it is exorpuscular. Hence the quinine should be given shortly before the paroxysm.

The manner of administering quinine is rendered somewhat difficult on account of the bitter taste of the drug and its insolubility in water. In very young infants, and in fact in the first six or eight months of life, it is well to try the effect of suppositories. In older infants and in children it can usually be successfully concealed in a small amount of chocolate cream.

The time for the administration of the quinine does not have to be regulated so carefully as in the adult. The dose can often be given with effect three or four times in the twenty-four hours. It is commonly given immediately after a paroxysm. I have been in the habit of giving it about eight or ten hours before the paroxysm is expected. It is well to continue the treatment with quinine for some weeks after the paroxysms have ceased, as the symptoms often return if the quinine is omitted at once.

The anæmia which always accompanies the disease to a pronounced degree should be treated with arsenite of potash, or with some mild form of iron, such as the saccharated carbonate or the tartrate of iron and potash.

These prescriptions, varied to suit the individual, are what I am in the habit of using in cases of malaria:

#### PRESCRIPTION 42.

*For an Infant under Six Months.*

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Quiniæ sulphatis . . . . .	0 36	R Quiniæ sulphatis . . . . . gr. vi;
Olei theobromæ . . . . .	11 25	Olei theobromæ . . . . . ℥iii.
M.		M.
Ft. suppos. no. 12.		Ft. suppos no. 12.
S.—One suppository to be used every 6 hours.		

#### PRESCRIPTION 43.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Ferri carbonatis saccharati . . . . .	0 90	R Ferri carbonatis saccharati . . gr. xv.
Ft. pulv. no. 15.		Ft. pulv. no. 15.
S.—For an infant under 6 months, 1 powder three times daily.		
For an infant from 6 to 12 months, 1 powder four times daily.		
For an infant from 12 to 18 months, 2 powders three times daily.		

## PRESCRIPTION 44.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Ferri et potassii tartratis . . . . .	3   00	R Ferri et potassii tartratis . . . . . ℥iiss ;
Glycerini . . . . .	18   75	Glycerini . . . . . 3 <sup>v</sup> ;
Aq. destil. . . . .	ad 90   00	Aq. destil. . . . . ad 3iii.
M.		M.

S.—For a child 2 years old, 2 c.c., or  $\frac{1}{2}$  drachm, three times daily.  
 For a child 4 years old, 4 c.c., or 1 drachm, three times daily.  
 For a child 8 years old, 6 c.c., or  $1\frac{1}{2}$  drachms, three times daily.  
 For a child 12 years old, 8 c.c., or 2 drachms, three times daily.

## PRESCRIPTION 45.

*For a Child Two Years old.*

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Liq. potassii arsenitis . . . . .	0   96	R Liq. potassii arsenitis . . . . . ℥xvi ;
Aq. destil. . . . .	ad 120   00	Aq. destil. . . . . ad 3iv.
M.		M.

S.—4 c.c., or 1 drachm, to be given every 8 hours.

In my experience, malaria may occur at any age.

Dr. Dane has recently mentioned to me a case (Case 150) of probable malaria (the blood was not examined) in an infant a few days old.

The infant's mother had malaria during her pregnancy, and some of the manifestations of the disease appeared ten days before the birth of the infant. The infant from the earliest days of its life showed symptoms of severe digestive disturbance, characterized by vomiting and diarrhœa, and far beyond what could be accounted for by the lack of equilibrium of the function of the mother's mammary gland.

Dr. Dane made a careful physical examination, but failed to detect anything abnormal in its thorax or abdomen.

Observations of the temperature in this case, taken both in the axilla and in the rectum, showed that it was of an irregular type, varying from 37.2° C. to 38.3° C. (99° F. to 101° F.) rectal, and that at times in the latter part of the day it rose to 39.4° C. to 40° C. (103° F. to 104° F.) axillary.

Every day at about 1 A.M. there was a paroxysm, represented by cyanosis, coldness of the entire skin, both of the body and of the extremities, collapse, and somnolence. These attacks, beginning at the seventh day of life, lasted until the twelfth day, when quinine in 0.03 gramme ( $\frac{1}{2}$  grain) doses, given in suppositories and administered every two hours for seven doses, at once and completely checked the paroxysms.

From this time the attacks entirely disappeared, the food was well digested, and the infant seemed perfectly well.

I have here in the wards to-day two cases (Cases 151 and 152) of malaria to show you.

One is this boy (Case 151), nine years old, who was admitted to my service on the 13th day of February.

He lived in a malarial district until one year ago. He had a slight cough, anorexia, malaise, night-sweats, and rapid loss of flesh for several weeks. The movements of the bowels were rather irregular. According to his mother's report, he had never before had any symptoms of malaria. On examining the child you will see that he is pale and emaciated. On physical examination you will find that there is resonance over both lungs, and on auscultation you will hear a few moist râles and an occasional sibilant



râle. The area of cardiac dulness and the sounds of the heart are normal. The liver is not enlarged, but the spleen, as you see, is very much increased in size, and I have marked the limits of its enlargement in black. You see that the upper border rises as high as the sixth rib in the axillary line, and extends down into the left inguinal region. An examination of the urine shows it to be normal.

CASE 151.



Boy, 9 years old. Enlarged spleen. Plasmodium malariae found in blood.

This is a case which represents the tertian form of malaria. The child had never had a chill until 3 P.M. two days after entering the hospital. The chill lasted about one hour, and was followed by sweating. A paroxysm of some kind, represented either by a chill or by a decided rise in temperature with chilly sensations, occurred on the 17th, 19th, 21st, 23d, 25th, 27th, and 29th of February, March 2, and March 4, and on March 6 there was a decided rigor at 4 P.M. On March 8 the paroxysm occurred in the morning at half-past twelve. On the morning of March 10 the paroxysm occurred at about half-past eleven, and was followed by marked sweating. Between the paroxysms the boy has appeared to be very well. He has had a fair appetite, and has gradually gained in weight and strength.

On March 10, immediately after the paroxysm, the blood was examined by Dr. Wentworth, and the plasmodium malariae was found. A specimen of the blood, which Dr. Wentworth has prepared to show you, is under this microscope (Plate V., p. 330). You will see the clusters of pigment in the erythrocytes in the various stages of the development of the parasites.

Here is the result of the examination of the blood :

BLOOD EXAMINATION 35. (Wentworth.)

Erythrocytes . . . . .	2,935,000
Hæmoglobin . . . . .	36 per cent.
Leucocytes . . . . .	25,500
Small mononuclear . . . . .	17 per cent.
Large       " . . . . .	27   "
Polynuclear . . . . .	56   "
Eosinophiles . . . . .	

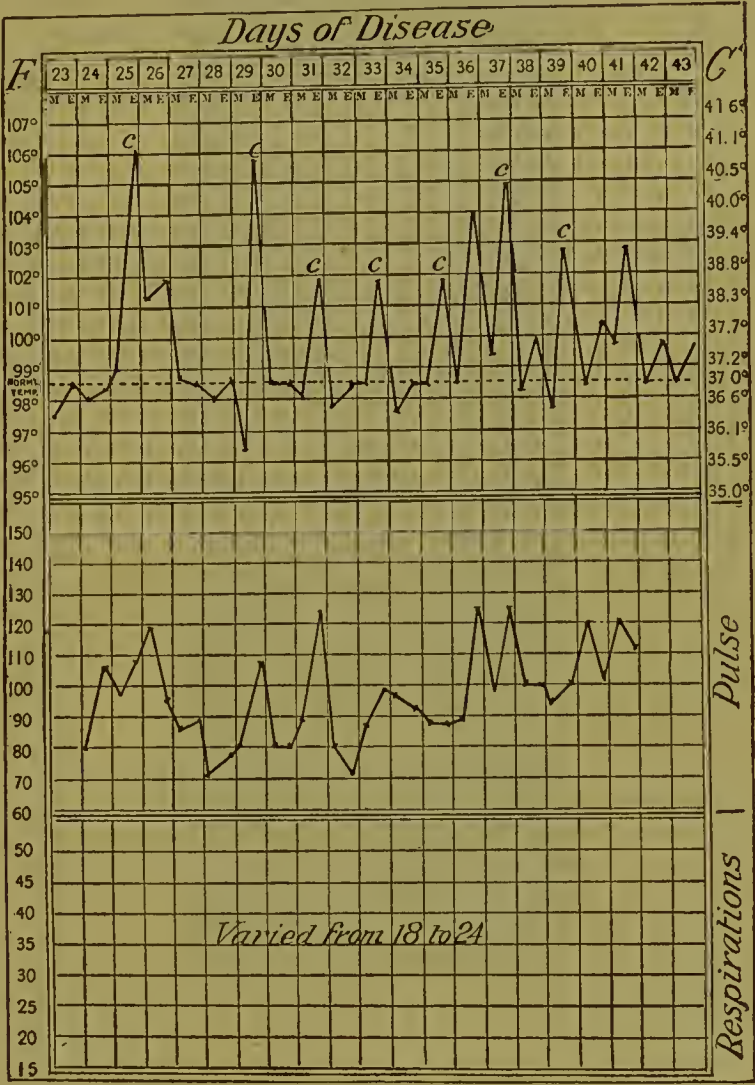
A large number of the erythrocytes contained the plasmodium malariae.

The large number of leucocytes pointed towards some complication, but none was at any time discovered.

The chills continued on March 12, 14, and 16. On March 17 0.36 gramme (6 grains) of quinine were given six hours before the paroxysm was expected to return. On March 18 there was no paroxysm. The quinine was given regularly three or four times a day for several days, and the paroxysms have not returned.

Here is the chart (Chart 6) representing the temperature and pulse of this case. The days representing the disease are necessarily only approximate for the first twenty-two days, and he is supposed to have entered the hospital on the twenty-third day of the disease. The first chill occurred on the twenty-fifth day, as is shown in the chart.

CHART 6.



Tertian form of malaria. (C means chill.)

(The subsequent history of this case was that the quinine was omitted, the chills did not return, the spleen recovered its normal size, the anæmia disappeared, and the child grew fat, and left the hospital in good condition.)

Here is the second case (Case 152) of malaria to which I have referred.

A girl, nine years old, who entered the hospital also on the 13th of the month.

She represents, in contradistinction to the tertian form of malaria seen in the boy, a case of the double tertian (quotidian) form. She has been living in a malarial district, but has never had any previous symptoms of malaria, although a sister living in the same

house has been affected by the disease. Four weeks before entering the hospital she had an attack of vomiting, nausea, and headache, without any apparent cause for them. These symptoms occurred at intervals for two weeks, when she began to have chills occurring every day at about 5 P.M. These chills continued, with the exception of four days, until her entrance to the hospital.

On examination you see that she is fairly developed and is very anæmic. On physical examination moist râles are heard over the bases of the lungs behind. The heart shows no

## CASE 152.



Girl, 9 years old. Enlarged spleen. *Plasmodium malariae* found in the blood.

increase in the area of dulness, but there is a soft systolic murmur over the whole præcordia. This murmur is most intense over the pulmonic area. The pulmonic second sound is not accentuated. The murmur is heard in the jugular veins. An examination of the abdomen shows it to be soft and tympanitic. The liver is enlarged, so that it extends 2.5 cm. (1 inch) below the border of the ribs. The edge of the spleen is plainly felt, and the percussion dulness extends downward to the level of the umbilicus and upward as far as the sixth rib. I have designated it, as you see, by a black line. The urine is high-colored and has a specific gravity of 1025, but is otherwise normal.

On the day of entering the hospital (the 13th) the child's temperature was raised, but there was no chill. On the following day, the 14th, there was a chill at 4 P.M. On the 15th there was a marked chill, with a considerable rise of temperature.

Immediately after the paroxysm an examination of the blood was made by Dr. Wentworth, with the following result:



## BLOOD EXAMINATION 36. (Wentworth.)

Erythrocytes . . . . .	2,396,250
Hæmoglobin . . . . .	30 per cent.
Leucocytes . . . . .	5,000
Plasmodium malarix present.	

It was noted that the splenic enlargement was greatest during the chill.

On the 16th there was a chill, and the temperature rose to 40.6° C. (105.2° F.), the maximum attained during the course of the disease.

On the 17th and 18th the chills recurred.

On the 18th 0.36 gramme (6 grains) of sulphate of quinine were given at 12.30 P.M.

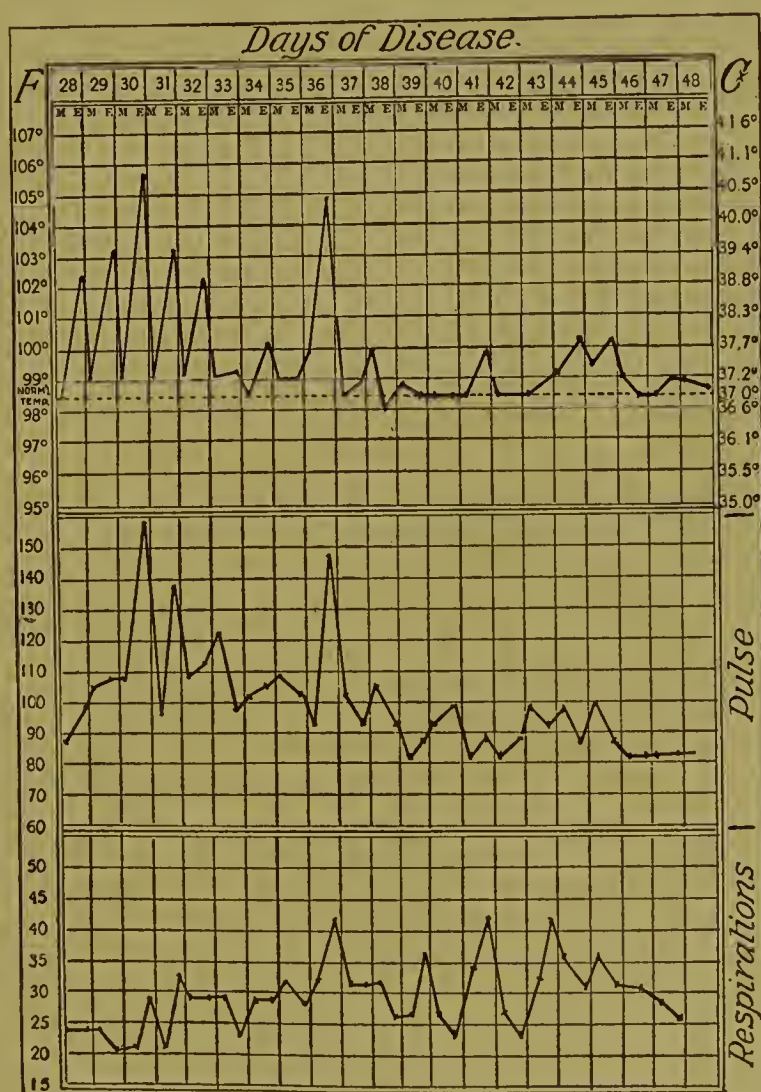
On the 19th there was no rise in the temperature, and no quinine was given.

On the 20th and 21st there were no chills, but a slight rise of temperature, and 0.12 gramme (2 grains) of quinine were given four times daily.

To-day, the 22d, she has just had a chill, and the temperature is 40.5° C. (105° F.).

Here is the chart of this case.

CHART 7.



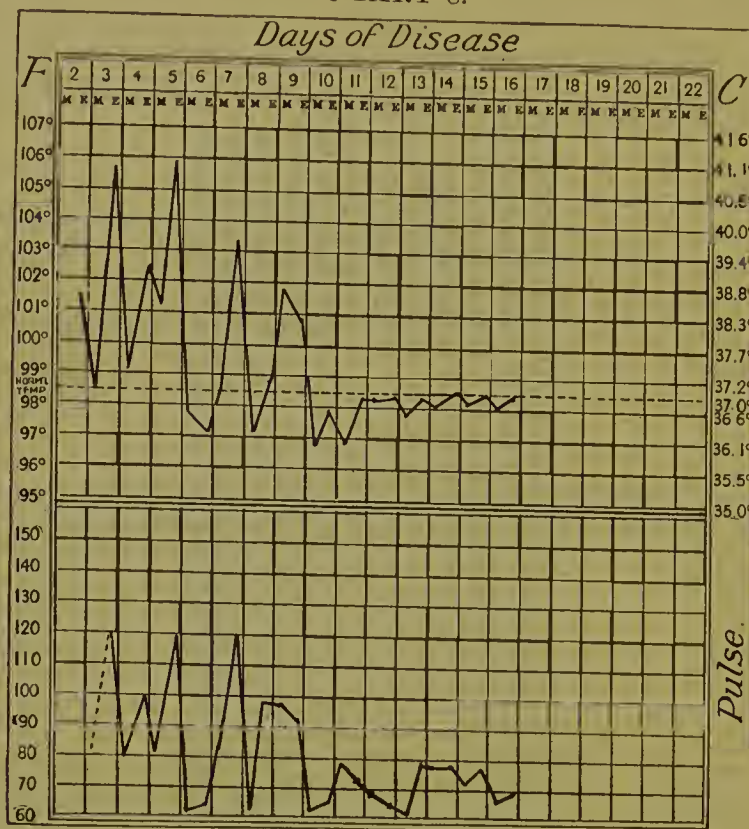
Double tertian form of malaria.

(The subsequent history of this case was as follows. 0.6 gramme (10 grains) of quinine were given in the course of each twenty-four hours for the next sixteen days, the spleen gradually growing smaller. As the temperature was still irregular, the quinine was then increased to 0.72 gramme (12 grains). The temperature remained normal for three days, and then was again slightly raised and irregular. Two weeks later the quinine was omitted,

and the spleen was found to be normal in size. Ten days later the child left the hospital in good condition.)

I have here to show you the chart (Chart 8) of the temperature and pulse of a boy (Case 153) nine and one-half years old, who was under my care with malaria.

CHART 8.



Tertian form of malaria.

He had been well and strong, and had not been living in a malarial district, but had spent a few days in the early part of May in a place where malaria had been known to occur occasionally. On May 7, after returning to his home, he complained of feeling tired and dizzy. On the following day, May 8, he complained of headache and of feeling chilly. He had no appetite, and in the evening was found to have a temperature of 38.6° C. (101.5° F.). He had two movements from the bowels on that day.

On the next day, May 9, his temperature at 7 A.M. was normal. At 8.45 A.M. he complained of nausea, of headache, and of feeling chilly. He had no appetite. His temperature at 1 P.M. was 40.8° C. (105.5° F.), and his pulse 120. He appeared to be very nervous and irritable.

On the following day, May 10, he felt perfectly well and bright, had no headache, a good appetite, a temperature of 37.2° C. (99° F.), and a pulse of 80. He continued to feel well until 7.30 P.M., when he complained of headache.

On May 11 his morning temperature was found to be 38.3° C. (101° F.) and his pulse 80. He had no appetite, was restless and nervous, but slept for two or three hours. His temperature at 8 P.M. was 41° C. (105.8° F.) and his pulse was 120. At 10 o'clock, after having a sponge bath given to him at a temperature of 35° C. (95° F.), his temperature fell to 38.3° C. (101° F.). He slept well during the night, and perspired freely. The spleen was found to be somewhat enlarged on this day, and nothing else abnormal was discovered on physical examination.

On the morning of May 12 the temperature was 36.5° C. (97.8° F.) and the pulse was 60. He felt perfectly well and bright, and had a good appetite. The movements of the bowels were rather loose.

On May 13 the morning temperature was normal and his pulse was 60. He felt well and bright until noon, when he had a rigor lasting twenty minutes. After the rigor he was



sleepy and tired, and at 3 P.M. the temperature was 40.5° C. (105° F.) and the pulse 120. At 6 P.M. he felt perfectly well again, his appetite returned, his temperature fell to 38.6° C. (101.8° F.) and his pulse to 100.

On the following day, May 14, he felt perfectly well, had a good appetite, and at 7 A.M. had a temperature of 36.1° C. (97° F.). On this day he had 0.06 gramme (1 grain) of quinine given to him three times a day.

On the following day, May 15, the record was that he had passed a quiet night, and that he woke early and seemed nervous. 0.3 gramme (5 grains) of quinine were given to him at 6 A.M. His temperature at 7 A.M. was 37.1° C. (98.9° F.). At 9 o'clock he began to grow sleepy; at 9.30 his temperature was 38.6° C. (101.6° F.), and at noon it was 41° C. (105.5° F.). At 7.30 A.M. his pulse was 82, at 9.30 A.M. 100, and at noon 120. At the time that he was having the high temperature his urine was large in amount and pale in color. At other times it was normal.

0.12 gramme (2 grains) of quinine were given on the following day, May 16, when the record was that he had passed a quiet night and that he waked at 2 A.M., seeming to be exhausted and complaining of feeling weak. His temperature was 35.5° C. (96° F.) and his pulse 48 and very weak. Thirty drops of brandy were given to him, and his pulse soon rose to 75 and was of a better character. He then slept until 7 A.M. At 7.30 A.M. his temperature was 35.8° C. (96.6° F.) and his pulse was 60. He appeared to feel bright and well all day, had a good appetite, and for the first time had a normal movement of the bowels. The temperature in the evening was 36.6° C. (98° F.) and the pulse was 60. At 7.30 P.M. he complained of slight pain in the bowels.

On the following day, May 17, 0.36 gramme (6 grains) of quinine were given at 5.15 A.M. His temperature remained normal all day, and his pulse varied from 70 to 80. He felt a little sleepy at noon, but his skin was natural. The bowels were moved regularly, and there were no abnormal symptoms.

On the following day, May 18, he was given 0.36 gramme (6 grains) of quinine at 5.30 A.M. He was perfectly well and bright all day, and had more appetite. He was given one grain of quinine three times during the day in addition to the 0.36 gramme (6 grains) at 5.30 A.M.

On the following day, May 20, he was out of bed and dressed all day, feeling perfectly well.

From this time until the 27th he continued to take 0.3–0.6 gramme (5–10 grains) of quinine during twenty-four hours, and he has since been perfectly well, with no recurrence of the malarial symptoms.

(No examination of the blood was made.)

I have also here to report to you the records of two infants who apparently were suffering from the effects of the *plasmodium malariae*, although no examination of their blood was made.

The first one (Case 154) was one year and ten months old. This infant had lived in a malarial district until within a few weeks of the time when I saw him in Boston.

The history which was given to me by his mother was that for several weeks he had had attacks, represented by a chill or chilly sensations, occurring every day at about noon. These attacks had recurred for about a week or ten days before I saw him. In connection with the chill and the fever the infant usually became unconscious, and its feet and hands were cold and clammy.

0.06 gramme (1 grain) of quinine was given to the infant on the 29th of April, and on the following day none of the usual manifestations occurred at noon, but at about 4.30 P.M. he had a chill and a slight rise of temperature, but was not unconscious. 0.03 gramme ( $\frac{1}{2}$  grain) of quinine was then given, and on the following day, April 30, 0.06 gramme (1 grain) of quinine at 10.30 A.M. On this day there was a decided chill, and the rectal temperature rose to 40.5° C. (105° F.). During the attack the child breathed rapidly; its feet, hands, and nose became cold, and it was practically unconscious for some minutes until its circulation was restored by injections of warm water and brandy. 0.03 gramme ( $\frac{1}{2}$  grain) of



quinine was then given three times during the twenty-four hours. On the following day none of these abnormal symptoms occurred. On the next day 0.03 gramme ( $\frac{1}{2}$  grain) of quinine was given in the morning and again at night, and this dose was continued for a few days.

From this time the symptoms of malaria entirely disappeared, the infant grew less and less emaciated, became stronger, had a good appetite, and continued to thrive.

No enlargement of the spleen was detected in this case.

The next infant (Case 155) was nineteen months old, and was brought from a decidedly malarial district.

It had previously been well until three weeks before it was brought to be treated for the following symptoms. At the time when its bath was given to it, which was between 11 and 12 in the morning, it had symptoms characterized by drowsiness and cyanosis, and it would fall asleep, and after about half an hour would wake up bright and well. These attacks, though short in duration, were very alarming and apparently serious, as, although the infant did not have any pain or convulsions, it could not be roused while in the attacks, and became so blue and cold that it was feared that it might die in one of them. At the time of the attacks the rectal temperature varied somewhat, but was usually about 38.3° C. (101° F.).

The treatment of this case was with sulphate of quinine, sometimes given by the mouth and sometimes by means of rectal suppositories. After the administration of the quinine for four or five days the attacks entirely ceased and did not return. The infant from that time continued to thrive.

This table (Table 89) contains references to most of the important articles which up to the present time have been published on the blood. You must remember, however, that it is not a general literature of the blood, but only that of an early period of development. It is the source from which I have drawn most of my information in the endeavor which I am making to elucidate the subject for you, and in this way I acknowledge what I have received from other authors.

TABLE 89.

1. ALT UND WEISS . . . . . Anæmia Infantilis Pseudo-Leukæmica. Centralblatt für die Med. Wissenschaft, 1892, Nos. 24 u. 25.
2. ANDREESSEN . . . . . Ueber die Ursachen der Schwankungen im Verhältnisse der rothen Blutkörperchen zum Plasma. *Dissert.* Dorpat, 1888.
3. ARNHEIM UND WIDOWITZ . . Searlatina. Morbilli.
4. BAGINSKY . . . . . Archiv für Kinderheilk., Bd. xiii., 1891.
5. BAYER . . . . . Ueber die Zahlenverhältnisse der rothen und weissen Zellen im Blute von Neugeborenen und Säuglingen. *Dissert.* Bern, 1881.
6. BOTKIN . . . . . Beitrag zur pathologischen Anatomie der Milz bei Pneumonia Crouposa. *Dissert.* St. Petersburg, 1892.
7. BOUCHUT ET DUBRISAY . . . Gazette Médicale de Paris, 1878.
8. CADET . . . . . Etude physiologique des Eléments figurés du Sang. *Dissert.* Paris, 1881.
9. CANON . . . . . Ueber eosinophile Zellen und Mastzellen im Blute Gesunder und Kranker. Deutsche Med. Wochenschrift, 1892, No. 10.
10. COHNSTEIN UND ZUNTZ . . . Pflüger's Archiv, Bd. xxxiv., 1884.
11. DAVIDOFF . . . . . Untersuchungen über die Beziehungen des Darm-Epithels zum lymphoiden Gewebe. Archiv für mikroskopische Anatomie, Bd. xxix., 1887.

TABLE 89.—*Continued.*

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|----------------------------------|--|
| 12. DEMME . . . . .              | 17. und 18. Bericht des Berner Kinderspitals, 1880 und 1881.   |
| 13. DEMME . . . . .              | Zwei Fälle von perniziöser Anämie. Jahresber. a. d. Berner Kindersp., No. 28.  |
| 14. DENIS . . . . .              | Recherches expérimentales sur le Sang, Paris, 1830.  |
| 15. DUPÉRIE . . . . .            | Sur les Variations physiologiques dans l'Etat anatomique du Sang. Thèse de Paris, 1878.  |
| 16. EHRLICH . . . . .            | Farbenanalytische Untersuchungen zur Histologie und Klinik des Blutes. Berlin, 1891. I. Theil.   |
| 17. EINHORN . . . . .            | Ueber das Verhalten der Lymphdrüsen zu den weissen Blutkörperchen. I. D. Berlin, 1884.   |
| 18. ENGELSEN . . . . .           | Virehow's Jahresbericht, 1884.   |
| 19. ESCHERICH . . . . .          | Ein Fall von perniziöser Anämie. Wien. Klin. Wochensch., 1892.   |
| 20. FANO . . . . .               | Lo Sperimentale, 1880.   |
| 21. FISCHL . . . . .             | Der gegenwärtige Stand der Lehre von kindlichem Blute. Sammelreferat. Prager Med. Wochenschrift, No. 12 u. f., 1892.   |
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## DIVISION VIII.

### DISEASES OF THE NEW-BORN.

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#### LECTURE XVIII.

##### MATERNAL IMPRESSIONS.—THE HEAD.—THE NECK.

UNDER the designation "diseases of the new-born" I shall now describe to you a series of cases which occur so early in life that they are most conveniently placed in a class by themselves. I shall not attempt to dwell upon all the conditions which are met with either at birth or within the first few weeks of life. That would require more space and time than the scope of these lectures will allow.

The diseases which we speak of as "diseases of the new-born" are distinct from those which are acquired later in life, in that they represent in almost every case an arrest of the normal development which should occur during intra-uterine life. This I have already referred to in my introductory lecture (Lecture I., page 19), and I only wish to impress again upon your minds that a stage of development which is normal at a certain period of intra-uterine life becomes abnormal if it persists to a later period, and that this persistence of an early stage of development constitutes in the great majority of cases what is known as congenital malformation. Such a failure of development may be the result of intra-uterine inflammation, which, either by crippling the various functions or by arresting the normal intra-uterine growth, produces a condition of disease at birth. In many cases, however, the causes are so obscure as to elude our usual methods of examination. "Diseases of the new-born" may also be made to include certain abnormal conditions which arise immediately after birth or in the early days of life.

Although many of these affections must pass into the hands of the surgeon for treatment, yet it is very important for the medical practitioner to be able to recognize at once their true nature and their significance. I shall, therefore, in this lecture attempt in a few words to tell you of some of the more common surgical affections of the new-born, as well as of those that are of a purely medical nature. In speaking of these diseases I shall, for the purpose of simplicity, classify them into diseases of



the head and neck, diseases of the trunk, diseases of the extremities, and general diseases.

**MATERNAL IMPRESSIONS.**—A few words should be said concerning the subject of maternal impressions. For many years there has been accumulating a considerable amount of evidence showing that a violent mental impression made upon a woman who is at the time carrying a child may be followed by a physical or mental defect in the child which bears a striking relation in character to the impression made upon the mother. Thus, Sir Walter Scott narrates that King James the First could not endure the sight of a drawn sword. This feeling has been attributed by those who believe in maternal impressions to the terror which his mother experienced at witnessing the murder of Rizzio. Still more numerous are the facts adduced to prove that bodily defects, such as harelip, club-foot, and hairy mole, may be caused by strong impressions of pain or terror experienced by the mother at the time when the foetus is in a certain stage of intra-uterine development. Interesting as these instances are, I think it is the general belief that nothing more has been proved than that they depend on a coincidence. The final decision on this obscure subject must rest on future investigation, and may cause us to guard a woman during her pregnancy from all unpleasant impressions with far more care than we do at present.

**THE HEAD.**—The normal average head at birth may be misshapen from various causes. Of the conditions which may cause unusual appearances, I shall refer merely to the most common. One of these conditions is called *caput succedaneum*, a case of which I have here to show you.

CASE 156.



Caput succedaneum. Male, 2 hours old.

**CAPUT SUCCEDANEUM.**—This infant (Case 156), a male, two hours old, presents a swelling over the right parietal bone extending back to the occiput and causing an irregular tumor and a great increase in the antero-posterior diameter of the head. You will notice that the tumor does not fluctuate.

The presentation was occiput left anterior, and no instruments were used. You see that the swelling corresponds to the place where there was the least pressure,—that is, the presenting part. It is needless to say that this caput succedaneum requires no treatment, as it gradually disappears of itself by absorption in a few days. It is simply a swelling of the scalp caused by a passive congestion with extravasation of blood and lymph into the connective tissue external to the pericranium.

*Caput succedaneum* must be carefully distinguished from another swelling of the scalp, *cephalhæmatoma*, which may occur in connection with it, and which appears as the caput succedaneum disappears.

**CEPHALHÆMATOMA.**—During labor a hemorrhage may take place from the blood-vessels of the head which gives rise to a tumor in one of

three situations: (1) between the occipito-frontalis aponeurosis and the periosteum; (2) between the periosteum and the skull; or (3) between the skull and the dura mater. The first two are known as external cephalhæmatoma, the last as internal cephalhæmatoma. The cause cannot be entirely pressure over the presenting part, as they have been found in breech presentations.

**External Cephalhæmatoma.**—By far the most common form is that in which the tumor has formed between the skull and the periosteum. It shows itself as an irregular circular swelling over a parietal bone, and gives on palpation a distinct feeling of fluctuation. The skin over it is not discolored or reddened. In those that have existed for a few days a bony wall can be felt surrounding the tumor, the edges of which give a crackling sensation under the finger. In this stage it may strongly suggest a fluid tumor coming through a circular hole in the skull.

The case (Case 157) which I have here to show you to-day is one of double cephalhæmatoma of the external variety; that is, it is an extravasation of blood under the perieranium.

Its base, corresponding to the denuded bone, is oval or circular. You will notice the bulging tumors on each side of the sagittal suture with a deep sulcus between them. On palpation you will get fluctuation, and on feeling the circumference of the tumor an elevation and crackling sensation as though you were touching fine crystals of ice on the edge of water which is beginning to freeze.

Cephalhæmatoma is distinguished from caput succedaneum by its sharp limitation to one of the parietal bones, by its fluctuation, and, if seen late, by its surrounding bony wall. It can be diagnosticated positively by the withdrawal of some of the fluid by a hypodermic syringe. Another condition which may simulate it somewhat is a depressed fracture. The differential diagnosis from this latter condition can best be made by remembering the fact that the resistant rim of the cephalhæ-

matoma is raised above the level of the surrounding bone, and is somewhat compressible, while on the inside it can be felt to slope evenly towards a fluctuating centre. In fracture no such arrangement occurs.

I shall now call your attention to this preparation (Fig. 86, page 406) of a double external cephalhæmatoma from the Warren Museum.

You see on the left side of the skull (the right side of the picture) the integument has been nearly removed, showing a raised bony rim.

On the right side of the skull (the left side of the picture) the integument has been cut off and partially deflected, showing the cavity which contained the effused blood.

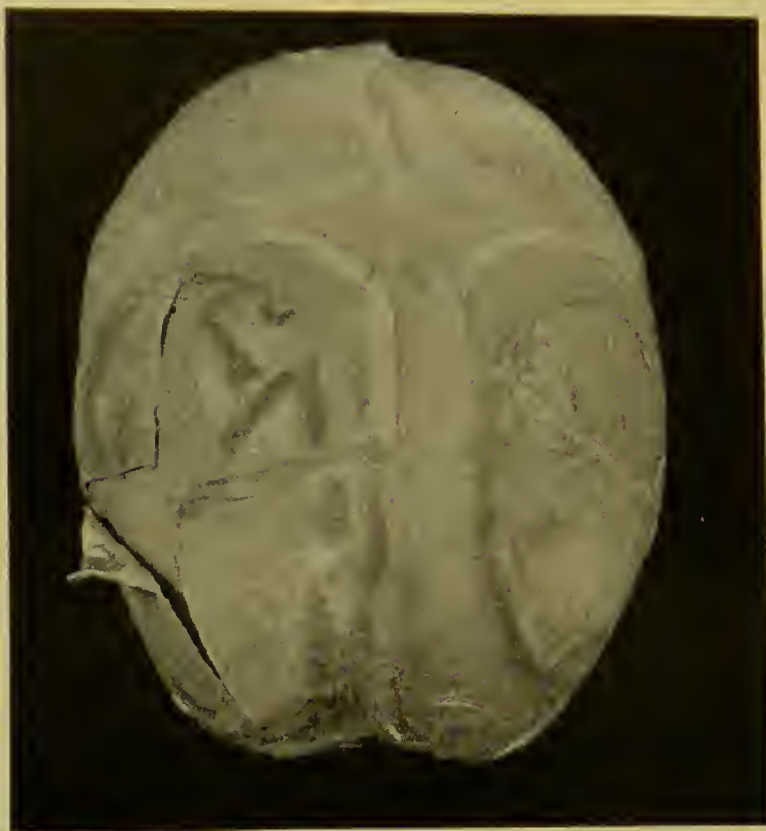
CASE 157.



Double cephalhæmatoma. Infant,  
4 days old.

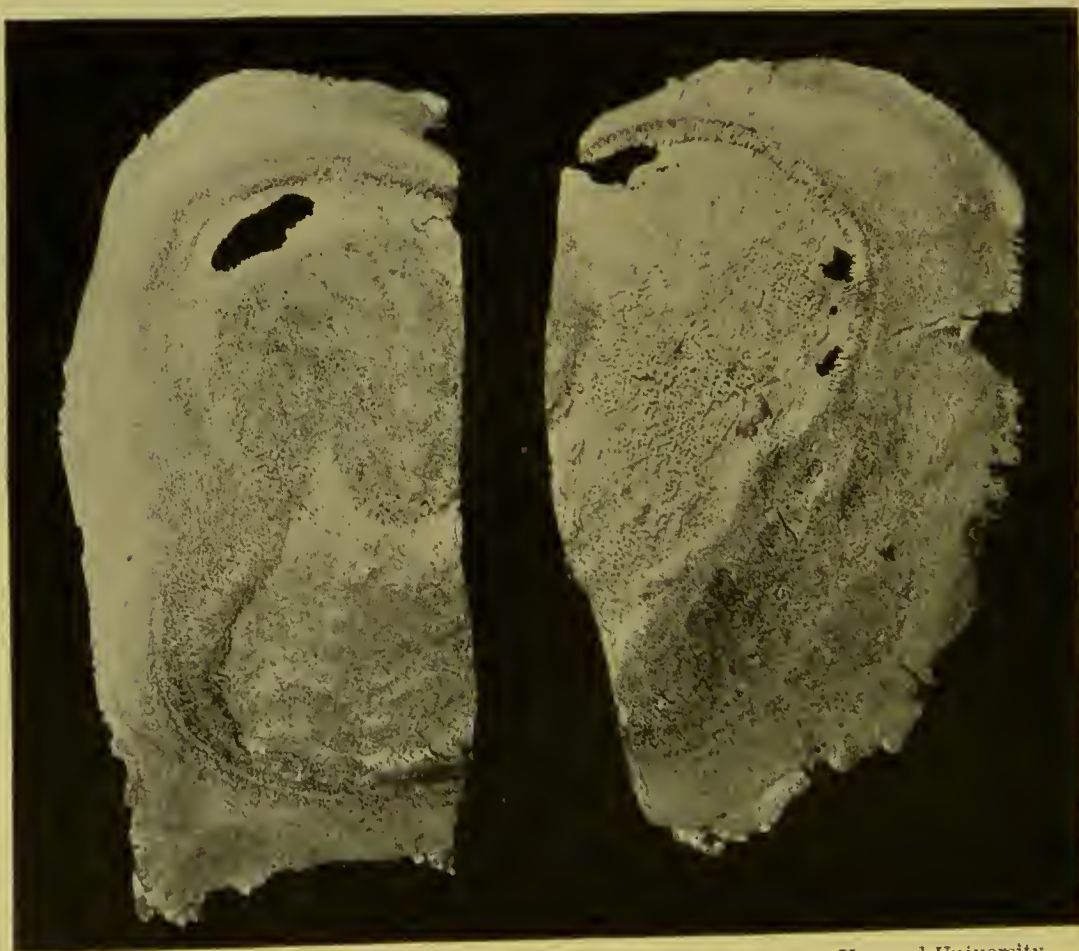


FIG. 86.



Double external cephalhematoma. Both parietal bones. Warren Museum, Harvard University.

FIG. 87.



External cephalhematoma. Parietal bone dissected. Warren Museum, Harvard University.



The next specimen (Fig. 87) is a parietal bone dissected so as to show the condition of the bone in a case of external cephalhæmatoma.

This specimen shows well the raised rim and the porous condition of the bone underlying the tumor. In two or three places the bone substance has entirely disappeared.

**Internal Cephalhæmatoma.**—Internal cephalhæmatoma is situated between the inner surface of the skull and the dura mater, and is rare. It is at times found in connection with the external variety.

The prognosis in this class of cases is bad. They are usually fatal, and there is no known treatment which can save them. I have here to show you the preparation (Fig. 88) of a skull taken from a case (Case 158) of internal and external cephalhæmatoma.

FIG. 88.



Internal and external cephalhæmatoma. Warren Museum, Harvard University.

The specimen was taken from an infant which was born at the Lying-in Hospital. Its death was caused by a large cerebral hemorrhage resulting from the internal cephalhæmatoma. It shows only the external cephalhæmatoma, which occupies the left parietal and occipital regions (shown on left of picture). Corresponding to this external cephalhæmatoma was a large effusion of blood occupying a space about 2.5 cm. (1 inch) in diameter, and lying between the dura mater and the brain substance, which was compressed by it.

**MENINGOCELE.**—By the term meningocele is understood a protrusion of some part of the membranes of the brain through a hole left in the cranial wall by defective ossification. In some instances this is caused by

an intra-uterine hydrocephalus. These tumors generally contain some of the cerebro-spinal fluid in the bag of membrane. Such fluid can often be reduced into the skull by gentle pressure, but at the risk of bringing on symptoms of cerebral disturbance.

This case (Case 159) shows a small meningocele above the left ear about 2.5 cm. (1 inch) in diameter.

Some fluid was withdrawn from it by an aspirating needle, and the contents of the sac proved to be serous without cells. The sac refilled after tapping. No more extensive operation on it has so far been undertaken.

CASE 159.



Meningocele. Female, 3 years old.

The history of this case is that the child is rachitic. It had a fall some time ago and struck its head. Nothing abnormal was noticed about the child previous to the fall, but since the accident this swelling appeared above and behind the ear. The swelling increases in size when the child cries, is soft, fluctuating, and not tender. The knee-jerks and sensation are normal. The ophthalmoscopic examination discloses nothing abnormal.

A much more serious condition is shown in the meningocele of this infant (Case 160).

It is a male, and was two weeks old when operated upon. Behind its left ear was an irregular tumor about 7.5 cm. (3 inches) long. The ear was pushed forward, and appeared to be growing from the tumor. The labor was normal, and the infant at birth was perfectly healthy and well formed, except for the tumor, which was congenital. On examination the tumor was found to be fluctuating and translucent. There were large veins on its surface. Pressure on the tumor caused no symptoms. No impulse could be felt on crying, nor did pressure cause any cerebral symptoms. On aspirating it, 45 c.c. (1½ ounces) of a clear reddish fluid were withdrawn. This fluid contained red blood-corpuscles and a few endothelial cells. No unfavorable symptoms followed the aspiration. After the withdrawal of the fluid two openings could be felt, the anterior probably connecting with the external auditory meatus and the posterior with the anterior fontanelle. The tumor was increasing in size so rapidly that an operation was decided upon. On removing it an opening in the skull large enough to admit two fingers was found.

The child made a rapid recovery from the operation, and now has only a scar behind the ear. There were no cerebral symptoms. During convalescence and up to the present time the child has seemed to be mentally bright.

**ENCEPHALOCELE.**—Still more common than the pure meningocele is that condition in which the hernia contains some of the cerebral substance as well as the membranes. This condition is called encephalocele; or if, as is often the case, it contains a portion of a dilated ventricle, so that the tumor is filled with cerebro-spinal fluid, it is known as hydro-encephalocele or as hydro-encephalo-meningocele.

Here are some photographs of a remarkable case (Case 161) of hydro-encephalocele which was treated by Dr. Lovett in the hospital.

The infant from the time of its birth had tonic and clonic convulsions, occurring usually as often as once in three hours. It was brought to the hospital when it was two months old. It was well formed in every way, except that it had a tumor on the back of its head which was at least one-third as large as its skull. The tumor was only partly covered with skin, the upper part of it being a thin translucent membrane. It communicated with



CASE 161.



Before operation.



Female, 2 months old. Hydro-encephalocele.



After operation.





the brain through a large square hole in the back of the skull. The tumor fluctuated slightly and appeared to be a multilocular cyst, for when it was aspirated only a part of the contained fluid could be withdrawn.

The tumor was removed by Dr. Lovett and the wound sewed up tightly. The cyst was found to contain a viscid fluid with slight flakes in it which proved to be particles of cerebral substance.

The convulsions immediately became less frequent, and ultimately on treatment with bromide of potash disappeared almost entirely.

The infant in other respects was very little affected by the operation, and recovered rapidly. After remaining in the hospital two weeks it was taken to its home, where it died some months later of some intercurrent affection.

Regarding these tumors in general, it is enough to say that you should view with suspicion any fluctuating swelling that seems to have a deep attachment in the neighborhood of one of the cranial sutures. The most frequent seat of these tumors is in the occipital region and at the root of the nose. Their treatment has not proved very successful. Some few may steadily decrease of themselves and ossification may block up the abnormal opening. Pressure and the injection of Morton's fluid have both been tried, and in some cases have been attended with success. At present the operative plan of treatment is considered the best. Without interference the tendency is usually towards rupture of the hernia, convulsions, and death.

ANENCEPHALIA.—As you have been taught in your course on embryology, the cerebro-spinal system is formed from the medullary tube, which is made by the infolding of epiblast along the medullary groove: if the formation of the medullary tube is for any reason incomplete, or if the dorsal wall of the tube is destroyed, the cerebrum or part of the cerebral axis will remain rudimentary. According to the amount of interference with the development we may find more or less of the brain remaining in a rudimentary condition, and thus producing greater or less degrees of what is called anencephalia. Total anencephalia is rare. Partial anencephalia is much more common. These cases are not of especial interest to us, as it is exceptional for them to live beyond a few days.

CONGENITAL HYDROCEPHALUS.—One of the more common malformations of the head is a hydrocephalic condition at birth. It is called congenital hydrocephalus, and I shall describe it in a later lecture (Lecture XXX., page 634), on diseases of the brain.

HARELIP.—The clearest way in which I can describe to you the malformation which I am now to consider is to remind you in a few words of the manner in which the parts around the mouth of the embryo are formed. You can then see at a glance how a failure of any part of the process in the development of that region will give rise to the several defects known as single or double harelip and cleft palate. At first the fore-gut of the embryo does not communicate with the outside, but ends blindly under the anterior region of the hind-brain. Over the end of the fore-gut curve the mid-brain and fore-brain, causing a prominence on the ventral surface of the

embryo. As the heart develops, another prominence is formed below the end of the fore-gut, and between these two prominences a wide shallow pit is found. At the bottom of this pit there is but a single velum, which separates the end of the fore-gut and the primitive mouth or stomodæum; later the velum is broken through and the two cavities form one canal. Above, this primitive mouth is bounded by the fronto-nasal process. Below, the boundary is made by the first visceral or mandibular arch, which has grown around the fore-gut from each side and has joined in the middle in front. The sides of the upper part of the buccal cavity are made by the maxillary processes, which growing from the base of the mandibular arch fill up the gap between it and the fronto-nasal process. The sides of the mouth are completed by the formation of the check-plates. The beginning of what in later life is to become the organ of smell is in the form of two small depressions, called the olfactory pits, in the sides of the fronto-nasal process, and immediately underlying the fore-brain. In the process of development these pits deepen and are partially surrounded by a semicircular ridge. The thickened inner edge of each olfactory pit now grows downward into the oral cavity, forming the mesial nasal process, and ends in a bulbous enlargement called the globular process. The mesial processes then grow backward along the roof of the stomodæum, forming the nasal laminae. The lower portion of the fronto-nasal process, which is originally situated between the olfactory pits, and includes the globular processes, gives rise to the intermaxillary region, the middle part of the lip and the lower part of the nasal septum and the portion of the fronto-nasal process between them. The bridge and point of the nose are formed by a pushing out of that part of the fronto-nasal process which lies immediately above. So far we have been following the development of the internal rims of the olfactory pits. The external rims grow also, but less rapidly, and project downward as the lateral nasal processes. From them are formed the alae of the nose. They begin by curling around the lower part of the nasal pits, but soon meet and coalesce with the maxillary processes of the mandibular arch, which you will remember I described to you as growing around each side of the roof of the primitive mouth. The lateral nasal processes and the maxillary processes eventually join in front with the intermaxillary process, and the union of all these makes the upper boundary of the mouth and shuts it off from the anterior nares. Behind this anterior bridge the nose continues to communicate freely with the mouth. Finally the palatine processes grow like two shelves from the inside border of each of the maxillary processes. These by their union with each other in the middle line and with the nasal septum complete the division of the nose and mouth. The median union of the palate begins in front by the eighth week and is completed by the thirteenth week of intra-uterine life. From what I have said you can easily picture how an arrest of this process would result in several kinds of deformity. If the maxillary process on one or both sides fails to unite with the intermaxillary, a cleft will remain open in the contour of



the upper lip on one or both sides of the intermaxillary bone, and hence we shall have single or double harelip as the case may be. If the cleft extends the whole distance from mouth to nostril it is called complete, but if the nostril is not reached by the opening it is called partial harelip. If there is a failure of the palatine processes to join, one or both nostrils will open into the roof of the mouth as well as into the pharynx, and we shall have the malformation known as cleft palate. This may be a huge chasm running the whole length of the roof of the mouth, or may be only a small opening, or nothing but a bifurcation of the tip of the uvula may be left to show that the normal process of development has not gone on to completion. An interesting and as yet unpublished observation on the persistence of an early condition of development in the lip has been made to me by Professor C. S. Minot, of the Harvard Medical School. If you examine the mouths of any set of men, you will be struck with the fact that in some of them the even contour of the upper lip appears broken by two rounded masses, each about the size of a pea, situated side by side nearly in the middle line. These are the remains of the two globular processes which have failed to be obliterated in the formation of the intermaxillary region.

Besides their unsightly appearance, which always causes the mother great concern, these malformations may so interfere with the infant's taking the breast as to render sucking impossible and make it necessary to feed the infant with a spoon.

I have here to show you a typical case (Case 162) of double harelip uncomplicated by cleft palate.

You will notice the large size of the intermaxillary bone, which protrudes considerably beyond the margin of the lips and is somewhat twisted upon itself. This alteration of the position of the intermaxillary bone may cause the teeth that grow from it to appear in very unusual places, as, for instance, protruding from the nostril.

CASE 162.



Double harelip.

Dr. J. C. Warren, who has examined the case, will now tell you what his ideas are as to the proper time for and the method of operating on harelip :

“The operation for the cure of the deformity of harelip consists in

removing the edges of the cleft with the knife or sharp seissors, and in bringing the portions of the lip together by sutures.

"The cut may be made so that the lower edge of the wound will project slightly, so as to avoid an indentation of the border of the lip when cicatrization has taken place. This may be accomplished by making a slightly curved or V-shaped cut in each margin of the cleft. When there is double harelip, the portions of the lip adherent to the intermaxillary bone should be refreshed, leaving a V-shaped flap hanging from the septum of the nose. The wound when brought together then forms a Y.

"The sutures which are usually applied produce almost invariably unsightly scars, owing to the traction which is exerted when the child cries. I have therefore devised a plan by means of which external scars are avoided. This consists in passing a fine wire through the cleft at the margin of the alæ of the nose and forcing the parts into apposition by a perforated shot, which is then clamped to the wire. In the case of single harelip the wire passes through the ala of the side affected and the septum. One of the shots is therefore concealed in the nostril of the other side. My other sutures are of silk, and are so taken that the knots are tied in the mouth and the rest of the suture is buried in the deeper portions of the lip. Three such sutures are usually sufficient to hold the lip firmly. A few very fine sutures such as are used for intestinal sutures may be applied on the exposed surface to make the coaptation of the edges of the wound complete. A band of crêpe lisse fastened to the cheeks by collodion removes the strain sufficiently to enable healing to take place promptly. The wire should remain in place for ten days, but the fine sutures should be removed in two or three days and the remaining sutures at the end of a week.

"These operations should be performed during the early weeks of life, as the growth of the facial muscles is not then sufficient to interfere with the healing of the wound."

The method of feeding these cases is important. Various devices have been used to promote the power of sucking, which is so much interfered with by the connection between the nasal and buccal cavities. Rubber nipples of peculiar shapes have been used, with the idea of artificially closing the opening in the hard palate while the infant is being fed. I have always preferred, however, to have the infant fed by the spoon, and not to have it suck at all until after it has been operated upon and the wound entirely healed. In this way we avoid the irritation upon the floor of the nasal cavity which would be caused by the introduction of rubber nipples or any other apparatus. The infants, as a rule, have no trouble whatever in swallowing milk introduced into their mouths by means of a spoon.

The method of feeding premature infants by means of Dr. Breck's tube (Fig. 42, page 313) is also a rational way of feeding cases of harelip, provided that the infant does not insist on sucking.

**CLEFT PALATE.**—In speaking of harelip I have described most of the conditions occurring in cleft palate. The difficulty of feeding, if the cleft



involves the hard as well as the soft palate, is very great, and must be met in the manner just described. The difficulty in articulation and the unpleasant sound of the voice are reasons which lead the parents to demand early treatment. We should wait a longer time before operating than in cases of harelip, as it is seldom wise to operate upon this deformity before the child is three years old.

The operation for cleft of the soft palate is called *staphylorrhaphy*, and is performed in this way. When the child has been put fully under the influence of an anæsthetic, and the mouth held wide open with a gag, the surgeon seizes the tip of the uvula with his forceps, and by the aid of a sharp blunt-pointed bistoury rapidly pares off a thin strip from the tip of the uvula to the angle of the cleft. Then, changing his forceps, he takes a similar paring from the opposite side, carrying the knife from the top of the cleft to the tip of the uvula. The fresh edges are then brought into apposition by a series of fine wire sutures, which are twisted tight and cut off. The levator and tensor palati muscles, together with the palato-pharyngeus, are then cut, in order to lessen the tension on the flap. This is accomplished by passing a thin-bladed knife completely through the soft palate close to the inner side of each hamular process: the handle is then raised a little and the knife withdrawn with its cutting edge downward. The anterior wound need be only slightly longer than the width of the blade.

The operation for closure of a cleft in the hard palate, called *uranoplasty*, is much more difficult, and, owing to the great success which has lately been attained by fitting artificial palates, is now passing into disrepute. For wide clefts *uranoplasty* is almost hopeless, but narrow ones may be successfully closed by its aid. It consists in marking out two side flaps parallel to the cleft on the roof of the mouth. These are dissected up with as much periosteum as possible for a distance a little in excess of the length of the cleft. The median edges of these flaps are refreshed and brought together by a row of sutures, just as was done in operating upon cleft of the soft palate. The final step of dividing the palatal muscles is the same in each. By many surgeons the lines of suture are in all these cases protected by a rubber plate made to fit neatly into the roof of the mouth.

The larger the opening in the palate the more successful will be the treatment by apparatus in comparison with that by the knife, for in the large openings there is so little opportunity for refreshing the edges of the opening and bringing them together that the operation is very apt to be unsuccessful. In using the apparatus, on the contrary, the larger the opening the greater the ease with which the artificial palate can be adapted. The artificial palate has also a uvula edge to it, and has in many cases proved eminently successful when applied by the hands of an expert.

Let me here emphasize the fact that after any operation upon the mouth of an infant the after-care, and especially the feeding, are of the utmost importance. The infant must be watched night and day to see that it does not put its fingers to its mouth and thus interfere with the stitches. Of



course every time it cries the strain is greatly increased upon the stitches. We must, therefore, impress upon the nurse the importance of continually amusing the infant.

**TONGUE-TIE.**—In quite a number of cases the frænum of the tongue is abnormally short at birth. In extreme cases the tip of the tongue is so closely bound to the lower jaw that it cannot be protruded beyond the line of the gum or touched to the roof of the mouth. The mother usually notices that the infant does not nurse readily, and brings it to the physician to discover the cause. In most cases on passing the finger into its mouth the infant is found to suck fairly well ; but there can be no doubt that this condition, which is called tongue-tie, interferes somewhat with the process of sucking.

The treatment is to cut the frænum. This operation should be followed by no hemorrhage and requires no dressing. Having the child's head held in a fairly good light by an assistant, and guarding the lower part of the tongue with the perforated flange of a director, a small cut is made in the tense frænum with a pair of blunt-pointed scissors. By making the cut close to the gum there is no danger of wounding the ranine artery. The cut is prolonged as far as is necessary by tearing with the finger-nail.

Children who have not learned to talk at the usual time in the second and third years are frequently brought to me with the statement that they are tongue-tied, and the parents wish me to treat this condition. Large numbers of children are brought to the physician under this supposition, but in very few instances are they tongue-tied. These children belong to a class which I shall describe when speaking to you of retarded speech (Lecture XXXVI., page 740). I shall merely say at present that the condition is a central one of the brain, and not a local one in the mouth, and that if children hear well and are bright and mentally well developed, even though they do not speak at the third, fourth, or even fifth year, as a rule they learn to speak later.

**RANULA.**—Beneath the tongue we sometimes find the mucous membrane bulging out as a bluish, translucent tumor which is soft, painless, and semi-fluctuating. This condition is called *ranula*, and is a retention cyst caused by the blocking of a mucous duct. When opened, a small amount of glairy fluid escapes, but the collapse of the walls of the cyst brings the edges of the cut together and they quickly adhere. The fluid will soon re-collect ; therefore the only sure way of dealing with these cysts is to pinch up their anterior wall with fine forceps, and with the scissors remove so much of it as to leave no opportunity for the edges to adhere. A gentle application of nitrate of silver to the edges and interior of the sac after the cut has been made with the scissors materially helps to promote the cure. It is not common in new-born children, but it occurs often enough to deserve mention.

**EARS.**—A deformity which is quite frequent at birth, and which increases as the infant approaches childhood, is the protrusion of the ears. The ear,

besides at times being placed in an irregular position on the head, has, in the cases to which I am now referring, a tendency to stand out from the head farther than is considered normal. This position of the ear usually annoys a mother very much, and you will frequently be consulted as to the means by which the deformity may be rectified.

In a large number of cases the persistent application of pressure by means of various devices, one of which is a fenestrated cap, will cause the ears to be flattened against the side of the head. In intractable cases an operation will have to be performed, but it is very simple and does not leave an unsightly scar. Dr. Warren's method for operating for this deformity is illustrated by one of my cases (Case 163), a boy eight years old, in which the operation resulted in a marked improvement in his appearance.

Dr. Warren dissects off a flap from the back of the ear that is shaped very much like the wing of a butterfly. A similar flap is taken from the side of the head just back of the ear. The two raw surfaces are then brought together, and the edges of the wound united with fine sutures. Dr. Warren tells me that the amount of tissue removed must be considerably larger than would seem at first sight to be necessary, because if the ear is not united to the head by a band of considerable thickness the subsequent stretching of the cicatrix allows of a return of the deformity.

**OPHTHALMIA NEONATORUM.**—This disease has been divided into two forms, the catarrhal and the purulent.

**Catarrhal Ophthalmia.**—The catarrhal form may be caused by any slight irritation of the eyes of the infant. It runs a very mild course, the inflammation attacking chiefly the palpebral conjunctiva. Often the only symptoms noticed are a slight photophobia and a collection of the secretion in the angles of the lids and upon their borders. Its whole course is mild, and often it is all over in a few days.

**Purulent Ophthalmia.**—Although a considerable number of causes for purulent ophthalmia in the new-born have been given, such as trauma, exposure to light and cold, and others, certainly ninety-five per cent. of all cases are caused by infectious material from the genito-urinary tract of the mother, and in most instances it is by gonorrhœal pus. If infection takes place during the birth of the child, the symptoms usually begin on the third day; but, as contaminated linen and fingers may carry the infectious material to the infant's eyes at a later period, the symptoms may be delayed indefinitely. The disease begins as a redness of the conjunctiva, with a slight discharge from the corner of the eye. This is succeeded with startling rapidity by intense inflammation of the lids. In twenty-four hours the upper lid may become so much swollen as to overhang the cheek and render opening the eye impossible. On separating the lids, a little greenish pus, which may even be tinged with blood, wells up between them. At first the cornea is unaffected, but if the pus accumulates under the œdematous lids it soon shows signs of ulceration. In the second twenty-four hours the ulceration may perforate the cornea and evacuate the aqueous humor, thus bringing



the iris into contact with the posterior surface of the cornea. The inflammation may extend around the eye and well over the forehead and malar prominence, but it does not last in the latter region very long.

All the symptoms disappear slowly, and recovery takes place, except in those cases where from ulceration the cornea has been permanently injured.

In treating this disease we must be very prompt and energetic. It often may be averted by what is known as Credé's method. This consists in dropping one or two minims of a two per cent. solution of nitrate of silver into each eye of the new-born infant. Although this has been known to cause even a considerable amount of irritation, yet it undoubtedly exerts a powerful influence in warding off this dangerous disease.

After the disease has once begun, two indications must be kept in mind : (1) to reduce the inflammation, and (2) to prevent the pus from accumulating behind the tightly-closed lids. By far the best way of applying cold to the eye is by compresses of thin, soft pieces of linen cut into small squares. Not more than two thicknesses are to be used at once. These compresses are to be cooled by laying them on a piece of ice or floating them in ice-water. They must be constantly changed. To remove the pus, a gentle irrigation, such as can be easily obtained by using a medicine dropper, is sufficient.

Remember that this secretion is highly contagious, not only for the infant's other eye, but for yourself. Therefore you must avoid all spattering, and should cover the infant's well eye before you begin the irrigation.

You should first turn the child's head a little to the diseased side, and with the fingers of the left hand gently separate the lids as far as possible. Then, holding the dropper with the right hand, irrigate between the lids, directing the stream *from* the nose. After each irrigation vaseline should be applied to the edge of the lids.

This should be done at least every half-hour, day and night, until the swelling has so far subsided as to preclude the danger of any secretion being retained.

For irrigation many solutions have been advocated. The most simple, and perhaps the best, is a saturated solution of boracic acid, or one of bichloride of mercury in the strength of 0.05 gramme (1 grain) to 480 c.c. (1 pint) of distilled water. In the later stages of the disease, where all the tissues are relaxed, a solution of nitrate of silver, 0.5 gramme (10 grains) to 30 c.c. (1 ounce) of distilled water, may cautiously be used once a day. This same solution painted on the conjunctiva with a camel's-hair brush once daily early in the disease is very effective in shortening the course of the disease.

It is not within the scope of these lectures to describe in detail scarification of the cornea or other measures which may become necessary to save extensive sloughing from strangulation.

**THE NECK.** HÆMATOMA OF THE STERNO-CLEIDO-MASTOID MUSCLE.—During the birth of the child, either from the violence of the expul-



sive efforts of the uterus, or, as more frequently happens, from the pressure of the forceps in head presentations, or from too vigorous traction upon the feet in breech presentations, or for no assignable reason, the sterno-mastoid muscle may be partially ruptured in its sheath and a hæmatoma form between the torn ends. This tumor may be either in the sternal or in the clavicular portion of the muscle, or may be just above the junction of the two. For a short time it is soft and tender, but gradually it loses its sensitiveness and becomes converted into fibrous tissue, which then tends to contract. It may appear as a small tumor, but in infants with fat necks it may not be noticeable at first. As turning the head towards the affected side lessens the tension upon the swelling, the infant will rigidly hold its head in that position. It is in this way that cases of infantile torticollis are thought by most writers to arise.

**TREATMENT.**—After the painful stage has passed, the treatment is by gentle massage and manipulations addressed to stretching the shortened muscle. If these methods fail, the child must be placed in the hands of an orthopædic surgeon for more extended treatment, either by apparatus or by division of the tendinous attachments of the sterno-mastoid muscle.

**BRANCHIAL FISTULÆ.**—At an early period of development the neck of the fœtus has along its sides a series of four branchial clefts, which communicate freely with the œsophagus and represent the gills of aquatic animals. The upper one of these forms the tympanum and the Eustachian tube, the rest are normally obliterated. Sometimes we find traces of these branchial clefts in the form of small fistulous tracts which admit a probe a short distance and end blindly. Their most frequent seat is just above the sterno-clavicular articulation, but they may be found anywhere along the anterior border of the sterno-mastoid muscle.

If they do not cause any inconvenience it is better to let them alone, as they often prove very intractable to treatment. If they are annoying from causing a slight mucous discharge, we can try to eradicate them with the galvano-cautery, or by passing a probe into the wound and dissecting from around it the lining of the sinus.

Sometimes the entrance of these fistulæ becomes stopped, so that they dilate and form large cysts containing mucus, blood, and atheromatous detritus. These form at times large and unsightly bunches, which require surgical treatment. Often the operation of obliterating them is not an easy one, for they are apt to have deep and complicated attachments.

LECTURE XIX.

THE TRUNK.

**MASTITIS.**—In certain infants during the early days of life we find a swelling and hardness of one of the mammæ. This condition appears to be an inflammatory one, and is abnormal. In connection with the swollen condition of the mamma, a secretion is found to come from the nipple which corresponds closely to milk, and which has been called “witches’ milk.”

A number of analyses have been made of this fluid, and here are some (Analyses 57 and 58) which represent the composition of it very well. Of course only a few drops of the fluid can be expressed from the mamma at one time.

ANALYSIS 57. (Schlossberger.)

Fat . . . . .	0.82
Casein, sugar, and extractives . . . . .	2.83
Ash . . . . .	0.05
Total solids . . . . .	3.70
Water . . . . .	96.30
	100.00

ANALYSIS 58. (V. Gesner.)

Fat . . . . .	1.45
Casein . . . . .	0.55
Proteids . . . . .	0.49
Sugar . . . . .	0.95
Ash . . . . .	0.82
Total solids . . . . .	4.26
Water . . . . .	95.74
	100.00

This condition occurs in boys as well as in girls, and, as far as I know, has no especial significance. With ordinary antiseptic precautions the inflammation usually subsides in a few days, leaving the affected breast the same size as the other.

I have here a female infant (Case 164) who represents this condition of the mamma.

She is one week old, and the swelling of the mamma was noticed on the fourth day of her life. You see a little fluid looking like diluted milk can be expressed from the mamma. The treatment of the case will simply be to keep it thoroughly clean by washing it with sterilized water, carefully drying it, and applying a compress with a little simple ointment on it.

**DEPRESSED STERNUM.**—There are a great many congenital malformations which may occur in different parts of the thorax. I have here

to show you a boy (Case 165) who was born with a depression of the lower part of the sternum.

He is now six years old, and has this rounded depression, about 4 cm. ( $1\frac{1}{2}$  inches) in diameter, beginning at the third costal cartilage and extending to the ensiform cartilage. He is perfectly healthy. The cardiac dulness extends to 2.5 cm. (1 inch) to the left of the mammary line, and its impulse is in the fourth left interspace. The spinal column is straight. The epiphyses of the wrists are slightly enlarged, but there is no other evidence of rhachitis. When he was two months old he had a severe attack of pertussis, which lasted for over two months. At five years of age he had a severe attack of bronchitis.

CASE 165.



Congenital depression of sternum. Male, 6 years old.

You see, therefore, that he has been subjected to influences which would tend to increase a malformation of this kind.

Although this depression of the sternum was present at birth, and has since increased in depth and in circumference, it now seems to have ceased to enlarge. The circumference of his head and that of his chest measure 50.5 cm. (20 inches).

The heart seems to be somewhat displaced upward and to the left, but is apparently unaffected by its abnormal position, and the boy's circulatory system will probably not be injured.

I have ordered for treatment light gymnastic exercises to broaden the chest and to strengthen the thoracic muscles.

Such a malformation as this sometimes results as one of the changes subsequent to Pott's disease. More often the sternum protrudes, but occasionally recession takes place, closely resembling the condition in this case.

**PROMINENT STERNUM.**—A prominence of the sternum, called *pigeon-breast*, occurs more often than the depression. It may happen without an assignable cause, or it may be due to rhachitis, and may also result from some spinal distortion, such as that of Pott's disease, or lateral curvature. In the latter case the sternum is often tilted to one side.

**SPINA BIFIDA.**—I shall next show you a series of that class of malformation called *spina bifida*. *Spina bifida* consists of a lack of closure of the laminae of the vertebrae. This condition is normal at a certain



period of intra-uterine life, but when persisting to a later period, and when occurring at birth, becomes abnormal from a developmental point of view and represents a distinct malformation. As the fusion of the laminae at the base of the spinous process takes place in sequence from above downward, the most frequent seat for spina bifida is in the lumbar and lumbo-sacral regions. There it appears as a tumor situated exactly in the middle line, covered sometimes with healthy skin, but as frequently roofed over by nothing but a thin adherent transparent membrane. Rarely the tumor is solid, containing nothing but an empty sac that has been walled off from its connections with the spinal canal. It is then called *spina bifida occulta*. In true spina bifida the tumor is filled with cerebro-spinal fluid, which can be seen to increase in amount as the child cries, and can, by pressure upon the sac, be forced back, in this case often giving rise to cerebral symptoms. According to the contents of the tumor, spina bifida has been divided into several varieties.

1. SPINAL MENINGOCELE.—When there is a protrusion of the membranes filled with fluid the tumor is called a *spinal meningocele*.

2. MENINGO-MYELOCELE.—The most common form is where the spinal cord, as well as the membranes, is found in the tumor. It then becomes a *meningo-myelocoele*.

The position of the cord in these tumors is a very variable one. It may run directly through the tumor, and even be suspended by a kind of mesentery, or, as is usually the case, it may be spread out like a fan over the surface; in any instance it is rudimentary in character.

3. SYRINGO-MYELOCELE.—*Syringo-myelocoele* is a rare form, in which the sac is formed of meninges and cord, the central canal of the cord being dilated to make the cavity of the tumor.

Spina bifida occurs usually in poorly-developed infants, and in a large majority of cases it is associated with other malformations, such as congenital hydrocephalus, harelip, club-foot, paralysis of the lower extremities, and in severe cases there may be incontinence of urine and of fæces. Sometimes the infant is well formed and healthy in every other respect.

If left to itself, the course of spina bifida is in one of two directions: (1) spontaneous closure and obliteration of the sac; (2) ulceration of the sac, usually followed by convulsions and death. In the first case, which is very rare, the sac shrivels up and thus effects a spontaneous cure. I happen to have here one of the first class of cases to show you (Case 166).

This boy, now four and one-half years old, shows an elevated cicatrix in the lumbar region, which suggests the former existence of a spina bifida. The case was of such interest that it was reported by Dr. Lovett in the *Boston Medical and Surgical Journal* as a form of spontaneous recovery from spina bifida. The case was seen by him when it was eighteen months old, and so far as could be learned there had been a large tumor present at birth similar to those which I shall presently show you. The sac burst in this case, and, contrary to the general result, the child did not die, but was left with paralysis of the legs, which makes it stand in this curious and abnormal position. He also suffers from incontinence of urine and of fæces. The child has never walked, and it seems probable that the present

disability is caused by the fact that the nerves were spread on the walls of the sac, as is usual in many cases, and that they were incorporated in the cicatrix.

## CASE 166.



Spina bifida. Spontaneous cure. Male,  $4\frac{1}{2}$  years old.

A result like this is, however, very exceptional. The rule is, either that there is an ulceration of the sac, followed by a large loss of cerebro-spinal fluid, convulsions, and death, or that the opening in the spine being very small the loss of fluid is constant, and the result is the same. In some instances there is an infection of pyogenic organisms through the walls of the sac, which causes a septic meningitis in the cord and finally in the brain. Such a case has been reported and beautifully illustrated by Dr. Holt, of New York, showing the presence of the bacteria and a resulting purulent hydrocephalus.

Here is a picture of another case (Case 167) of spina bifida which will illustrate the ordinary course of the affection.

It shows a large spina bifida in the dorso-lumbar region. The membrane covering the tumor was so translucent that the spinal cord could be plainly seen through it. At birth

there was a small tumor. It filled with fluid at the end of twelve hours, and at the end of forty-eight hours it looked as it does in this picture. The top of the tumor suppurated, the fluid began to leak away, and the child died within ten days.

## CASE 167.



Spina bifida of dorso-lumbar region. Infant 48 hours old. Died when 10 days old.

This is the course pursued by the disease in the majority of cases which are not operated upon.

The next case (Case 168) is an illustration of a spina bifida in the lower dorsal region.

## CASE 168.



Spina bifida in lower dorsal region. Infant 5 days old. Died when 7 days old.

The sac was not so tense as in the case (Case 167) of which I have just spoken, and it was possible by feeling deeply with the fingers to find the opening in the spinal column. This opening was about 7.5 cm. (3 inches) long and 3.8 cm. ( $1\frac{1}{2}$  inches) wide. The tumor was not covered with skin, as in the case previously mentioned, but with a thin, translucent membrane.

The infant was seen by Dr. Lovett in consultation twelve hours after birth, and an operation was deferred for a few days to see if any favorable change would occur. The operation was undertaken on the fifth day, as the sac showed signs of ulcerating and breaking. The sac was excised without apparently injuring the nerves, and the wound was closed by a plastic operation. The infant died in convulsions within forty-eight hours of the operation.

The next patient I have to show you (Case 169) is another case of spina bifida.

The boy is now five years old, and has had this large tumor since birth. It is situated over the lumbar region of the spinal cord, and is in the median line. The fluid has been withdrawn several times for purposes of examination, and when the sac is lax an opening



5 cm. (2 inches) long can be felt in the spinal canal. It is elliptical in shape. From the fact that the child suffers from incontinence of urine and has a certain degree of paralysis of the legs, it is fair to infer that the nerve-supply of the legs and pelvis is incorporated in the tumor.

## CASE 169.



Spina bifida of lumbar region. Male, 5 years old.

This case has been tapped and treated with an injection of Morton's fluid, but this treatment was entirely unsuccessful, and although the sac has been aspirated several times the fluid has always returned. There is little hope of the boy's being relieved by an operation ultimately, and he will probably continue to be a cripple for life.

**TREATMENT.**—Various methods for treating spina bifida have been proposed, and some of them warmly advocated. Repeated aspiration is one of the most simple, but its results have not been satisfactory. Ligature of the neck of the sac, if the sac is small, or the application of a clamp, has cured a few cases. Electricity has been recommended for this affection, as for about everything else in the field of medicine.

The two methods that are in the best repute are the injection of Morton's fluid and the plastic operation. Morton's fluid is a solution composed as is shown in this prescription (Prescription 46):

## PRESCRIPTION 46.

(Morton's Fluid.)

<i>Metric.</i>		<i>Apothecary.</i>	
	Gramma.		
℞ Iodi . . . . .	0   60	℞ Iodi . . . . .	gr. x;
Potassii iodidi . . . . .	1   80	Potassii iodidi . . . . .	gr. xxx;
Glycerini . . . . .	30   00	Glycerini . . . . .	℥i.
M.		M.	

From 1 to 4 c.c. (15 minims to 1 drachm) are used at each injection, which may be repeated several times at intervals of a fortnight. The reports of the Clinical Society of England show that more cures and fewer

deaths have been reported following the use of this solution than from any other method.

Another method is the plastic operation. This is performed as follows. The tumor is opened, the nerves are dissected carefully from the walls of the sac and are returned to the spinal canal: the sac is then sewed up, and, if possible, used as a plug for the opening. It has been recommended that the laminae of the vertebrae on both sides of the cleft should be broken and turned in. Finally, after the excision of all the thin covering, the fresh edges of the sound skin are united. To accomplish the closure of the wound, and yet to avoid dangerous tension on the stitches, it may, in the case of large tumors, be necessary to dissect up two lateral flaps of skin from the loins and slide them inward to join in the median line. The majority of cases which have been so operated upon have died within a week, but the few successes that have been attained lead us to hope that with a more perfect technique the results of the operative treatment of spina bifida may be such as to warrant our advising it in any case where the tumor threatens to rupture and where the child is otherwise fairly developed. You must clearly understand, however, that the operation will in most cases not help the paralysis or incontinence, and may very possibly increase instead of diminish a hydrocephalus, if this latter condition exists as a complication.

CASE 170.



Hydrocephalus, dorsal spina bifida, club-foot.

This photograph illustrates the condition of hydrocephalus accompanying spina bifida, which I have just described. The infant (Case 170), a case of Dr. Osler's, represents a combination of spina bifida, hydrocephalus, and paralytic deformity of the lower extremities.

**PHLEBITIS AND ARTERITIS UMBILICALIS.**—The cause of both of these conditions is a septic infection of the umbilical stump. It is considered by most pathologists to begin as an inflammation of the perivascular cellular tissue, and only secondarily to invade the walls of the vessels. The region around the umbilicus is red and hot, and we may be able by gentle pressure to squeeze a few drops of pus from the stump of the cord. It is a very dangerous affection, as septic emboli readily pass from the infected vessels into the general circulation and set up metastatic inflammation in the thoracic as well as in the abdominal organs.

**TREATMENT.**—The treatment is to sustain the infant's vitality by stimulation and thoroughly to disinfect the umbilicus with solutions of bichloride of mercury or carbolic acid, followed by the application of boracic acid or iodoform powder. A flaxseed poultice is often of service, and some authors recommend placing the infant upon its abdomen in order that gravity may aid in draining away the pus.

**CONGENITAL UMBILICAL HERNIA INTO THE CORD.**—Dr. Howard Marsh, in the Report of St. Bartholomew's Hospital for 1874, calls attention to the "familiar anatomical fact that from about the sixth to the twelfth week of intra-uterine life the cæcum and neighboring portions of the ileum are contained in the part of the umbilical cord which is next to the body of the embryo, and that they should subsequently withdraw into the cavity of the abdomen. In some cases, however, this recession fails to take place, and the intestine remains, even up to the time of birth, still lodged in the beginning of the cord, which is dilated in the form of a membranous sac." Not only may portions of the intestine be thus left outside of the abdominal wall, but, as in a case recently operated upon by Dr. Warren, the liver may be found lying in a hernial sac made from the dilated base of the umbilical cord.

The infant (Case 171) was sent to Dr. Warren at the Massachusetts General Hospital a few hours after its birth. At the umbilicus was seen the cord, which was greatly distended at its point of insertion into the abdomen, forming a tumor 6.5 cm. (2½ inches) in diameter. The coverings of the cord were inserted into a raised rim of skin, and were opaque, so that the contents of the hernia could not be determined.

When the infant was one day old, Dr. Warren enlarged the umbilical ring somewhat, separated the liver from the myxomatous tissue of the cord, which was in some places firmly adherent to it, and returned the mass within the abdomen. The wound was tightly closed with strong silk sutures. There was considerable shock following the operation, but there were no symptoms of peritonitis. In two weeks the wound had healed, and the infant recovered.

**FUNGUS OF THE UMBILICUS.**—The umbilical cord, after being ligatured at birth, falls off by the seventh or eighth day, leaving a clean, dry cicatrix. After the separation of the cord we sometimes find a red protrusion, with a moist surface, that may even have a short central canal. This is generally due to an imperfect disintegration of the cord. It may bleed very readily if touched, and may give rise to a discharge so irritating that



the skin for some distance around the umbilicus becomes eczematous. This condition is called *fungus* or *polypus of the umbilicus*.

The treatment is very simple. The larger ones are best removed by ligation; the smaller ones can be destroyed by the application of nitrate of silver or the actual cautery.

**MECKEL'S DIVERTICULUM.**—A condition which may at first simulate umbilical polypus, and of which umbilical polypus may be a symptom, is the persistence of a *Meckel's diverticulum*. This consists in the persistence of a piece of intestine, usually patent, connecting the small intestine with the umbilicus. It represents a vitelline duct that failed to atrophy when the placental circulation became established, and betrays its presence by an escape of fæces from the umbilicus. It is a rare malformation, but one which you should recognize at once.

I have here to show you the picture of a case (Case 172) that came to the Infants' Hospital last winter during the service of Dr. Lovett.

CASE 172.



Persistence of Meckel's diverticulum. Infant 3 days old.

The infant at entrance was three days old and was very well nourished. You will notice the protrusion at the umbilicus, on the top of which is a bright red granulating surface, appearing black in the picture. There was a considerable faecal discharge from the polypus, and the skin of the abdomen was much irritated in its vicinity. A medium-sized probe could with ease be passed 6.5 cm. ( $2\frac{1}{2}$  inches). Laparotomy was performed by Dr. Lovett. The diverticulum, which was found to arise from the middle of the ileum, was resected and the intestinal wound sewed up. The polypus was not disturbed at the first operation, its blind stump being sewed off even with the inside surface of the abdominal wall. The line of incision, which was about 2.5 cm. (1 inch) to the left of the polypus, and 8.7 cm. ( $3\frac{1}{2}$  inches) long, healed by first intention. A week afterwards the polypus was removed by two applications of the actual cautery. The infant was allowed to return home, but came back ten days later with a double pneumonia, from which it died.

**UMBILICAL HERNIA.**—The ordinary umbilical hernia, which is simply a protrusion of a knuckle of the intestines through the unclosed abdominal opening left by the separation of the cord, is of very common occurrence. The lighter grades tend to recover spontaneously, and it is not advisable to operate upon them, or in fact on any umbilical hernia, until it has proved to be absolutely intractable, for it is an operation accompanied

by considerable danger to the life of the infant. The lighter grades of umbilical hernia are usually easily reduced, but there is often great trouble in keeping them so. Various devices are employed for this purpose, but most of them are very unsatisfactory. At the Children's Hospital we are in the habit of proceeding in the following manner.

Having gently reduced the hernia, the skin of the abdomen is so pushed up between the fingers that it makes a vertical fold, at the bottom of which lies the umbilicus. The hole should be deep enough to lay one's finger in it. The tension is kept up by applying a wide strip of adhesive plaster transversely across the abdomen. This makes a pad of flesh, which closes the umbilical opening and retains the intestine in place. The cure is a slow one, and the treatment must be continued for many months in severe cases, without once allowing the hernia to come out. The milder cases are also aided by exercises which tend to develop the abdominal muscles. This can be very simply effected by having the child lie on the floor, and, while the feet are held down, making him rise to a sitting position with the back held straight. This is accomplished by the rectus muscles of the abdomen, and if the opening is a transverse one it tends to close it.

This case which I have here to show you (Case 173) is an infant five months old. The hernia, as you see, is very large, and has caused an eversion of the whole umbilical region. It represents an extreme grade of the disease.

CASE 173.



Umbilical hernia. Infant 5 months old.

Cases of incarcerated and even strangulated umbilical hernia have been reported, but are very rare. A few have been operated upon successfully. The danger from all such procedures is usually considered great, but there has been such an advance made in the modern methods of abdominal surgery that the operation is looked upon with increasing favor.

**INGUINAL HERNIA.**—The most common forms of *inguinal hernia* that occur in young children are (1) the congenital, (2) the funicular, and (3) the infantile or encysted. An ordinary acquired form such as is the rule in the adult may be met with, but it is not so common.



(1) CONGENITAL FORM.—The congenital form is that variety in which the knot of intestine has made its way along a still patent funicular process. If it reaches into the scrotum it will be found completely to envelop the testicle.

(2) FUNICULAR FORM.—In the funicular form, the tunica vaginalis having become shut off from the funicular process just above the testicle, the hernia comes down the patent process, but does not envelop the testicle as in the preceding variety.

(3) INFANTILE FORM.—Compared with the two forms just mentioned, the infantile or encysted form of hernia is quite rare, nor can it be diagnosed with certainty without an operation. In it the funicular process has closed above but not below, and the intestine encased in a pouch of peritoneum forces its way into the process and descends.

The diagnosis between direct and indirect hernia has little importance in childhood, as the inguinal canal is so short that the rings are practically at the same level. Most of the herniæ that you will meet in children are easily reducible, but you should remember that in attempting to get them back into the abdominal cavity you must use the greatest care, as nowhere can a little rough manipulation do more harm. If the hernia cannot be easily replaced, you must not think of leaving it where it is, simply because it gives rise to no alarming symptoms on the part of the child. No infant is safe with an irreducible hernia, and the sooner you put such a case in the hands of a surgeon the better. Strangulated and incarcerated herniæ occur at times as in adults, although they are rare. They demand the same treatment.

The condition with which you will most readily confound hernia is hydrocele. Both give rise to an elastic tumor in the inguinal region and in the scrotum, and in fact they resemble each other in many ways. Let me point out to you some of their differences.

Hydrocele is translucent by transmitted light; hernia is opaque. Hydrocele is always dull on percussion; hernia is usually resonant. If you can reduce them, hydrocele will go back slowly and noiselessly, hernia at the last quickly and with a gurgling sound. Hydrocele gives no impulse on coughing; hernia usually does. Lastly, in feeling for the inguinal ring in hernia you find it filled with the neck of the tumor; in hydrocele it is either empty or filled by a narrow stalk.

TREATMENT.—Although the treatment of inguinal hernia, whether by actual operation or by the application of the usual trusses, should be in surgical hands, yet one method of treating these herniæ is so simple and safe that every medical man should know about it; in fact, in our children's clinics here in Boston it is much used for all children under a year and a half. This method is the application of a worsted truss like this one.

The infant (Case 174) whom I am about to fit with this truss is eight months old. You see the bulging of the hernia here on the left side. Below it, feeling like another little sac,



is the testicle. We are, therefore, dealing with the funicular form. The mother tells me that she noticed the hernia when the infant was two weeks old, and that it has grown steadily larger.

On laying the infant on his back on the table, you see that after a minute of gentle taxis the hernia can be reduced, but it comes out again with a jerk when the child begins to cry.

I shall now ask Dr. Dane, who has had much experience with these cases on the surgical side of the hospital, and who has given me much valuable advice on the surgical bearing of all these cases which I have been describing to you, to reduce the hernia again and keep it in place.

Dr. Dane, as you see, having reduced the hernia, and having the nurse prevent it from coming down by placing her finger over the inguinal ring, passes a skein of Germantown yarn under the infant's back and brings the left-hand end of it around its left side, with the strands separated so as to form a loop, till it rests over the nurse's finger. Through the loop he puts the right unseparated end of the skein, and carries it down the left groin, and up on to the back, where he finishes by tying it to the middle of the skein as it crosses the hollow of the back just above the buttocks. As you see, he has, by thus threading the right closed end of the skein through the separated strands at the left end, made a kind of soft slip-knot which lies directly over the inguinal ring, and, when the whole is put on tightly, makes an excellent truss.

Having told the mother to buy some skeins like this one, and having shown her how to adjust it herself, she can keep a clean truss, by washing them, on the child for a period of months, and if she is faithful in carrying out her part of the treatment the herniæ, which do not depend upon an actual malformation of the ring, will probably be cured. If these herniæ are not cured within a year, the surgical treatment of the present time is by operation.

The next case (Case 175, facing page 430) which I have to show you came under Dr. Lovett's care at the Infants' Hospital, and had to be operated upon :

This boy, who is now four years old, first came to the hospital two years ago. He then had a double inguinal hernia, both rings admitting the end of the index finger. He was fitted with worsted and pad trusses, but failed to return after the first few weeks. As you now see, the left ring has grown so much smaller that the hernia no longer descends. The right inguinal ring easily admits the middle finger, and when the hernia comes down it is quite large. Below it you can feel the testicle. As the treatment with a truss has failed entirely, an operation will be advised.

In connection with this case I wish to speak of a complication that may exist with any hernia in male infants. If you will feel below the hernia of this child (Case 176), you will find no trace of the testicle, nor do you have any better success after you have reduced the hernia. In this instance the testicle is not adherent to the bowel, and has not been pushed back with it, as is sometimes the case, but seems never to have left the abdominal cavity. I shall return to this subject again when speaking of the diseases of the testicle.

I must call your attention to a remarkable case that came into the hands of Dr. Monks, my colleague at the Boston City Hospital :

The child (Case 177) was two years old. Two months before he was seen by Dr. Monks the child's mother noticed a hard bunch in the right inguinal region. This became larger and more painful till, at this time, it extended the whole length of the inguinal canal and into the scrotum. The most prominent part was midway between the external ring and the testicle. It was very tender, about 2.5 cm. (1 inch) long, and quite hard.

There was no impulse on coughing. On aspiration there were found a few drops of pus, but on trying to find the cavity again with a director, nothing but inflammatory tissue was met. Under poultices the tenderness disappeared and the tumor was reduced somewhat in size.

On operation, two weeks later, the cause was found to be a hernia of the vermiform appendix, followed by an acute attack of appendicitis. The caput cæci and the base of the appendix were found inside the abdomen, and in a normal condition. An appendectomy was performed, and the child made a perfect recovery.

**FEMORAL HERNIA.**—In femoral hernia the gut escapes from the pelvis under Poupart's ligament, and, making its way through the femoral canal, shows itself as a tumor directly under the saphenous opening. It can be diagnosed at once from inguinal hernia by putting the finger on the spine of the pubes and noticing whether the origin of the tumor is to the outer or the inner side of that point. If outside, you are sure the hernia came through the femoral canal, no matter how far it may have extended up on to the abdomen. Femoral hernia is, however, extremely rare in young children, even in girls. In infancy the spine of the pubes, Poupart's ligament, and the anterior superior spine of the ilium are all much nearer together than in the adult. As a consequence, the femoral opening is so small and so well protected that it is usually impossible for the hernia to force its way through. Dr. Cushing, my colleague at the Children's Hospital, has reported a case (Case 178) of irreducible femoral hernia in which the sac contained a mass of omentum so matted together as to give a feeling that without special care might have been mistaken for that of lipoma. Such a condition must certainly be very rare. Dr. Cushing has described in his account of his operation upon this case a new incision that must prove very useful.

**HYDROCELE.**—I have already spoken of the general appearance of hydrocele in giving you rules for differentiating it from inguinal hernia, with which it is often associated.

Several anatomical varieties are met with in hydrocele, as in hernia. Thus, if the collection of fluid occupies a freely open funicular process, we have the *congenital variety*, and the fluid can easily be returned to the abdominal cavity by placing the child on its back and elevating the scrotum. This is true also of *funicular hydrocele*, where the fluid occupies an open funicular process, but is bounded below at the point where the tunica vaginalis has become walled off, leaving the testicle in a separate compartment underneath. Where the funicular process has become walled off from the abdomen, but is still in communication with the tunica vaginalis, there may be a collection of fluid, which is then known as an *infantile hydrocele*; in this form the fluid is irreducible. True hydrocele of the tunica vaginalis may be met with in children as well as in adults, but it is rare.

**ENCYSTED HYDROCELE OF THE CORD.**—There is another form of hydrocele which often escapes recognition, but perhaps still oftener is diagnosed as hernia and treated with a truss. This is the encysted hydrocele of the cord.

If in the course of the spermatic cord a hard, rounded swelling appear,

CASE 175.



Double inguinal hernia, cured on left side.  
Male, 4 years old.

CASE 180.



Hernia and hydrocele. Boy, 7 years old.





and you find the testicle in its proper position in the scrotum and the inguinal ring clear, you are very surely dealing with a hydrocele of this kind. Having made your diagnosis, you can proceed boldly to its evacuation with a fine aspirating needle. You will probably draw off about 4 c.c. (1 drachm) of clear straw-colored fluid, and the tumor will disappear.

A case (Case 179) of this kind was brought to the hospital last winter and entered in the service of Dr. Lovett. A little below the inguinal ring on the right side was a small tumor. The mother said that she had noticed the swelling for about a week, and the day before had carried the infant for advice to a local physician. He had attempted to reduce what he supposed was a hernia by gentle taxis. Failing in this, he gave the infant ether, but again was unsuccessful. The next morning, in company with an associate, he etherized the infant and tried unsuccessfully for an hour to effect reduction.

The infant was then brought to the hospital for operation. The hydrocele was aspirated, and with the removal of a little over 2 c.c. (30 minims) of clear fluid all trace of the supposed hernia disappeared.

The infant was brought back a week later, as the hydrocele had again accumulated. A second aspiration effected a cure.

I mention this case in order to impress upon you how careful the physician who is practising among children should be not to meddle with cases which should at once be placed under the care of a surgeon.

ENCYSTED HYDROCELE OF THE CANAL OF NUCK.—Analogous to hydrocele of the cord in boys is an accumulation of fluid in the canal of Nuck in girls. The appearance of the swelling is the same in both cases, and the treatment should be the same.

TREATMENT.—The treatment of all forms of irreducible hydrocele is first by aseptic evacuation of the fluid with a fine canula and trocar, or by an aspirating needle. If this, after repeated trials, fails to effect a cure, extirpation of the sac is the only sure method, although the injection of a weak solution of iodine is highly recommended by many authors. It is, however, dangerous in children, as the occasional connection of the hydrocele sac with the abdomen is not to be forgotten.

Reducible forms of hydrocele are generally to be treated by a truss, in the same manner as herniæ, to try to effect a closure of the neck of the canal. If this is successful they can then be treated in the ordinary way. The outlook, however, is poor, and such treatment is generally unsatisfactory.

As an instance of hernia and hydrocele, I have here this case (Case 180, facing page 430) of a boy seven years old, in whom the gross appearances are the same as in the case (Case 179) just shown you.

You see on reducing the hernia that the scrotum remains distended with fluid, which cannot be reduced into the abdominal cavity by any gentle manipulation. We are therefore dealing with a true hydrocele of the tunica vaginalis. The knuckle of intestine does not descend to the bottom of the scrotum, because the scrotum is filled with the hydrocele. The hydrocele is translucent and fluctuating.

The treatment will be to try to reduce the hernia and to cure the hydrocele by tapping. If these methods fail, we shall have recourse to a radical operation and treat both conditions at the same time.

I would here mention that cases of hernia, whether umbilical or inguinal, are especially difficult to manage if the infant has some such disease as pertussis. There seems to be some evidence that hernia is hereditary. Félizet reports eighty-five cases of hernia occurring in his practice, where, omitting all cases in which the father pursued some laborious trade, such as that of a blacksmith, he found that in 24.7 per cent. the parents had had similar herniæ. Malgaigne reports a percentage of 29 due to heredity in a series of three hundred and sixteen cases of hernia.

Infants are at times brought to our hospitals with a history of colic who, on examination, are found to have more or less incarceration of these herniæ. This should impress upon you the importance of making a systematic physical examination in every case for abdominal hernia, and of not taking it for granted that the symptoms are caused by indigestion.

**TESTICLE.**—The testicle should descend into the scrotum at about the eighth month of intra-uterine life. In certain cases it does not descend, and if the descent does not take place within the first few years of life its function is lost from its becoming atrophied. It is, therefore, important in those cases where the testicle descends and returns to the abdominal cavity to retain it in the scrotum by means of apparatus. Operation for this condition is not often successful. At times an undescended testicle is found in combination with an inguinal hernia. A case of this kind came under my care about two years ago.

A little boy (Case 181), four years old, was found to have an inguinal hernia. The testicle was also found at times to be absent on the side of the hernia. Sometimes the hernia would descend and the testicle remain in the abdominal cavity, and again the testicle would come down with the hernia. It was exceedingly difficult to maintain the testicle in the scrotum, even when it was found to be there, as it would slip back with the greatest facility.

I placed the case under Dr. Lovett's care, and he finally succeeded in seeing the boy at a time when both the testicle and the hernia were down, and in reducing the hernia while the testicle was kept in the scrotum. A carefully adapted truss now prevents the testicle from returning to the abdominal cavity and the hernia from entering the scrotum.

**TUMORS OF THE TESTIS.**—We may at birth find an enlargement of the testis due to sarcoma or carcinoma. The former is much the more common. As an illustration of this type of disease I will show you this infant (Case 182), who was operated upon by Dr. Lovett three months ago.

After a normal labor, it was noticed that the infant had a swelling as large as an egg on the right side of the scrotum. This was at first considered to be a hydrocele, but, as it steadily increased in size, more active measures were employed. On bandaging, the skin over the tumor, which was at first normal, became so much inflamed that lead water had to be used as a wash. The treatment had no effect on the size of the scrotum or on the discomfort which it seemed to cause the little patient. The infant was now two weeks old.

As the tumor had a semi-fluctuating feeling, aspiration was tried, and 2 c.c. ( $\frac{1}{2}$  drachm) of blood-stained serum were obtained. A second tapping gave only a little clear blood.

The infant was then brought to Dr. Lovett for consultation. The tumor was found to be quite large, being 20 cm. (8 inches) in circumference, and it had nearly hidden the penis



in its mass. After a preliminary tapping, which gave the same result as the previous one, an operation was performed. A testicle 5 cm. (2 inches) in diameter was removed. The cord, which was found enlarged to a diameter of 1.2 cm. ( $\frac{1}{2}$  inch), was removed as far up as the external ring, but laparotomy, in order to extirpate the cord as fully as possible, was not performed. The infant made an excellent recovery, and no return of the growth can be detected in either the scrotum or the pelvis.

On section, the tumor was found to contain scattered throughout its mass about a dozen cysts of different sizes. Microscopic examination showed it to be a mixed-cell sarcoma with fibrous and myxomatous tissue in different parts of it. Here and there were scattered small areas of cartilage and a few striped muscular fibres. As you know, muscle fibres are found in the tumors of only two organs, the kidney and the testicle, and even in these they are very rare.

**MALFORMATIONS ABOUT THE RECTUM.**—In speaking of harelip I told you in a general way how at an early stage of development of the embryo the intestinal canal ended blindly and afterwards by an invagination of the outside wall a communication was brought about and the stomodæum formed. An analogous process of development goes on at the other end of the intestinal tube, and results in the formation of the rectum and anus. The hind-gut at first ends blindly, then as it descends it is met by an ascending dimple, and usually these two fuse and the *protodæum* is formed.

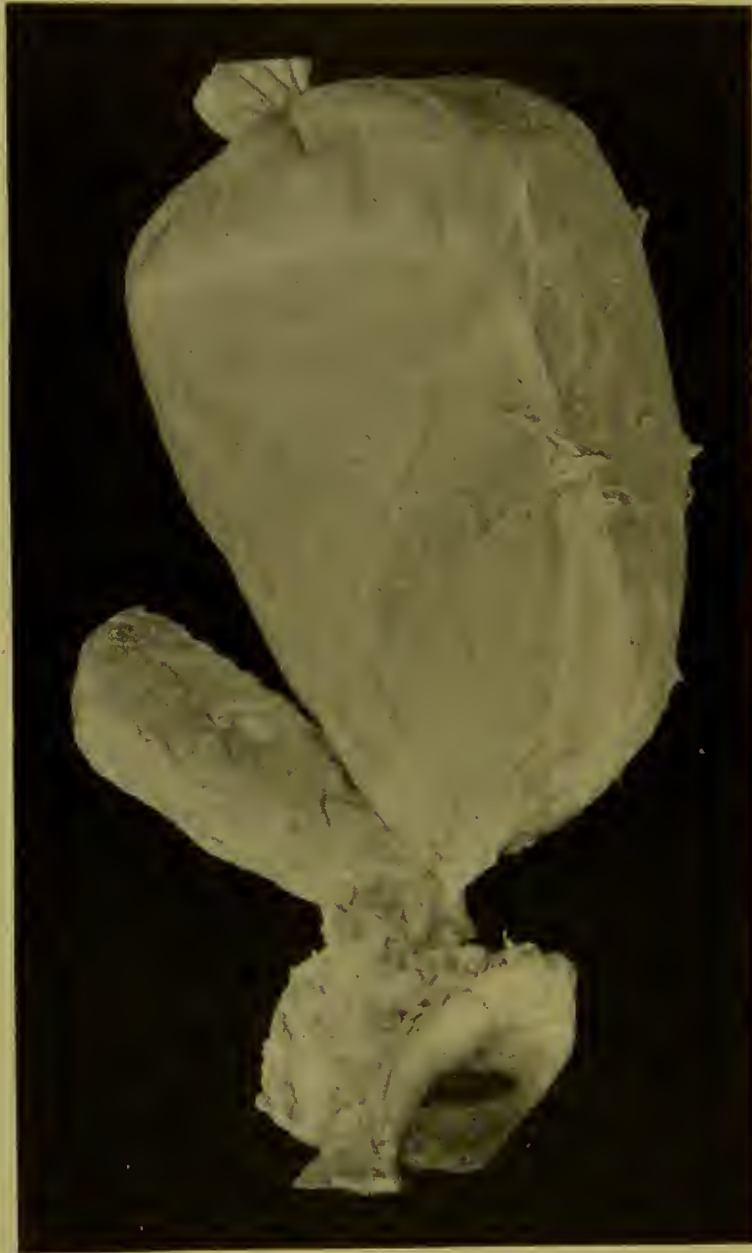
As in the mouth a series of malformations may arise from a failure in the completion of this process, so in the anal region we may meet with a similar series. The rectum may have come into its normal relations and the anal depression have failed to form, or it may have gone the whole of the distance between the end of the intestine and the skin and yet the final step, the fusion of the membranes, have failed to take place. To both of these, and to any intermediate condition, the name of *imperforate rectum* is given. On the other hand, with the rectum and the anus fused we may, nevertheless, find a thin parchment-like membrane spread over the external orifice just where the skin and the mucous membrane join. This is called *imperforate anus*.

When an infant is born the physician should carefully examine it, in order to determine whether it has any malformation. The most important malformations which it is necessary to recognize are those at the anus. Unless an infant has a passage of meconium soon after its birth, an examination should be made in the rectum with the finger, and if the anal opening is found to be closed, either just at the outlet or higher up, we must consider what is to be done to relieve this condition. If nothing but a web obstructs the anus, we can easily break it through with a director and then dilate the orifice with the finger. If there is more than the thinnest bulging membrane, a cutting operation will have to be done, and perhaps a severe one. The general principles are to begin with a staff in the bladder, and, using this as a guide, to make a careful and systematic dissection in search of the missing gut. If we fail in this, we should perform the operation known as Littré's, which consists in opening the sigmoid flexure in the inguinal

region and making an artificial anus there. There is a still more severe form of operation, in which an attempt is made to cut through the sacrum and make the gut open there, but it has many practical objections in very young infants.

Here is a specimen (Fig. 89) taken from an infant, a patient of Dr.

FIG. 89.



Imperforate rectum. Male, 14 days old. Warren Museum, Harvard University.

John Ware's. It died on the fourteenth day of its life. From the time of its birth it had constant vomiting and much distress. The autopsy showed the lower part of the small intestine and the whole of the large intestine to be acutely inflamed, and that there was ulceration of the latter. You see that the upper and lower portions of the intestine terminate in a cul-de-sac a short distance from the anus and are separated for about 0.85 cm. ( $\frac{1}{3}$  inch).

The large bulging mass above represents the rectum distended with meconium and separated from the anal opening by an isthmus of solid

connective tissue. The smaller mass in front (to the left in the picture) is the bladder.

**OCCLUSION OF THE VAGINA.**—Sometimes we find a thin gray velum extending across the mouth of the vagina from just below the urethral opening to the posterior commissure and blocking up the vagina. It may be complete or partial. This condition should be dealt with while the infant is still young, as if left until puberty it will cause a retention of the menses, and, moreover, by that time will have become much thicker and perhaps quite vascular. It is easily broken through in the young child, and if a piece of carbolyzed cotton be put between the torn edges to prevent their adhering, the malformation can be cured permanently. Atresia from inflammation of the labia is said to occur in rare instances.

**HYPOSPADIAS.**—The malformation known as *hypospadias* is the result of an arrest of development in the formation of the urethra and of the corpus spongiosum. The urethral groove should normally be converted into a canal by the growth and joining together of its sides. This process begins at the base and extends to the end of the penis. By an interruption of this process the urethra may be brought to an end and open at any point between the peno-scrotal angle and the base of the glans. In the most common forms of hypospadias the glans alone is imperforate.

**TREATMENT.**—The treatment is wholly by plastic operation, and it requires the most delicate surgery to obtain a good result in the face of the many serious obstacles that this malformation presents.

**EPISPADIAS.**—The malformation of *epispadias*, in which the urethral canal opens upon the dorsum of the penis, is still more difficult to deal with than is hypospadias. It is commonly associated with extroversion of the bladder, and is very rare.

A partial plastic operation and the wearing of some form of urinal constitute about all that can be done for these cases.



## LECTURE XX.

## THE EXTREMITIES.—GENERAL DISEASES.

**FINGERS.**—Various malformations of the extremities are met with in new-born infants, and I happen to have one of these to show you to-day.

This infant (Case 183) has six fingers on each hand instead of five.

This is only one of a type of malformations which you are liable to encounter. Another malformation of this kind, called webbed fingers, is quite common.

CASE 183.



Infant's hand with six fingers.

**TOES.**—Infants are at times born with *extra toes* and *webbed toes*, and it becomes a surgical question to determine whether they shall be operated upon. This, of course, is a question of orthopædics, and is one which we need not deal with except so far as to appreciate the importance of preparing the foot properly for future use.

The greater freedom of movement required for the fingers, and the fact that the hand is always in sight, render surgical interference much more necessary in malformations of the hand than in those of the foot.

*Congenital hypertrophy* of the feet and hands, and *congenital deficiency* of one or more extremities, may be spoken of in this connection, but are too rare to be more than referred to.

These malformations have been thoroughly described by Thomas Annandale, and I shall refer you to his work on this subject for information regarding them.

**CLUB-HAND AND CLUB-FOOT.**—Club-hand and club-foot are congenital malformations which may be due to an undeveloped condition of either the bones, the ligaments, or the muscles. In the more simple forms the extremity is pulled into the malposition by the action of contracted muscles and tendons, while in the severe forms the bony framework may be so misshapen that the separate segments are almost unrecognizable. Club-hand is often accompanied by absence of the radius.

**TREATMENT.**—The treatment of this class of deformities is, of course, purely in the province of the orthopædic surgeon. All that I wish to do in referring to them is to suggest to you how much may be accomplished by simple manipulations with the hand. The mother should be instructed to rub the foot and leg twice daily, and to make firm pressure against the shortened muscles by trying to bring the hand and foot into the normal

position. I have seen light cases cured by this simple means, and even moderately severe ones so much benefited that subsequent treatment with orthopædic apparatus became much easier.

**CONGENITAL DISLOCATION OF THE HIP.**—Congenital dislocations of all the joints are sometimes found, the most frequent and most important being dislocation of the hip. This is now thought to be caused by a faulty development of the acetabulum and the head of the femur. The symptoms are of a kind that readily escape notice during infancy, and are first seen when the child should begin to walk. It is then noticed, if he can hold himself on his feet at all, that the abdomen is very prominent, the back arched, and the buttocks seemingly enlarged: at least this is the case if the deformity is bilateral, which is the form usually met with. On examining the joint we find that the trochanter is above Nélaton's line, but it can by traction on the leg be drawn down to its proper place without causing any discomfort to the child. If the deformity is unilateral, one leg will appear shorter than the other, and the child will walk with a rolling limp. This condition should be carefully looked for when an infant at the age of fourteen or fifteen months has made no especial attempt to walk, or when on attempting to do so it does not succeed.

As operative treatment has not proved very successful in these cases and is not to be employed until the child is over three years old, the best method of treatment is by massage. If the disease is unilateral it should in addition to the massage be treated with a high shoe.

**CONGENITAL DISLOCATION OF THE KNEE.**—Next in order of frequency to congenital dislocation of the hip, but rare in comparison, is

CASE 184.



Congenital partial dislocation of the knee. Female, 5 months old.

a dislocation, or rather a partial dislocation, of the knee. In this condition the tibia is found riding forward upon the femoral condyles, so that the

knee-joint can readily be put into hyperextension and the toes made to point towards the forehead. Here is a case (Case 184, page 437) which illustrates this condition.

The infant is five months old, and was delivered with instruments after a long labor. It was a head presentation. As you see, there is a remarkable range of motion at the knee. Not only can I put it into hyperextension, but I can move it considerably from side to side. This abnormal mobility is due to a very lax condition of all the tissues about the knee, and especially of the lateral ligaments. It has been treated, its mother tells me, by a plaster bandage for about a month, and no improvement has taken place. We should not be at all surprised at this result, when we consider that keeping the knee immovable simply tends to increase the already existing atrophy.

A far better form of treatment is the application of a light steel support which will check all lateral motion and by means of a "stop joint" at the knee will allow flexion but will prevent hyperextension. This apparatus, together with systematic massage, will probably effect a cure.

**BIRTH PARALYSIS.**—Birth paralysis will be considered in connection with diseases of the nervous system. It may be present either in the muscles of the face or in those of the extremities, and is due to pressure upon the nerves made by the forceps or by too great traction.

**CONGENITAL OBLITERATION OF THE BILE-DUCTS.**—One of the rarer forms of congenital malformations in new-born infants is represented by the *obliteration of the bile-ducts*. The most extended work which has appeared in the literature of this subject is that of Dr. John Thompson, of Edinburgh, whose valuable thesis I have used in my description of the disease.

**SYMPTOMS.**—The infants who are born with this disease are either icteric at first or become so within the first few weeks of life. They often appear otherwise healthy and well nourished. In some cases there is a discharge of normal meconium followed by colorless dejections. In other cases the fecal movements are clay-colored from the very first and remain so. The urine is deeply stained with bile. The jaundice is of a dark-greenish tinge, lasting until death. Spontaneous hemorrhage from the umbilical cord commonly occurs within the first two weeks, and in other localities in those infants who survive this early period. The liver and spleen are increased in size. If the infants survive for some months they become more or less emaciated. Convulsions and vomiting are apt to occur, and death usually takes place from exhaustion or from some trifling intercurrent disease.

**PATHOLOGY.**—There are a number of different morbid processes which have been supposed to produce this pathological lesion of the ducts. Each of these processes has in certain cases, in all probability, had much to do with causing the disease, but it is usually the combination of one or more of them which must be considered in determining its etiology. Thus, the results of intra-uterine peritonitis, by compressing the ducts, or by being a source of inflammation which has spread to the walls of the ducts, may finally cause their obliteration. A primary inflammation or lesion of the



ducts themselves may produce this result, or it may arise from an actual arrest or defect of development. In this connection congenital syphilis should be referred to as in some cases producing lesions of the ducts, but this and other causes do not necessarily play an important part in the disease.

The complete discussion of the causes of congenital malformation of the bile-ducts would hardly have a place in a general work on clinical medicine, but it is sufficient to say that in the great majority of cases the evidence is in favor of defective development as being the chief cause. This malformation probably affects to a considerable extent the walls of the ducts, and, as Thompson has stated, it consists in the narrowing of their lumen. The interference which is thus caused to the outflow of bile gives rise to a catarrhal condition which finally blocks and obliterates the ducts, owing to the inflammatory process spreading to the walls of the ducts and the gall-bladder. This progressive inflammation goes on slowly spreading, the local condition gradually becoming worse during many months if the patients live. The obliterated ducts or gall-bladder, or portions of them, may entirely disappear, not even leaving a distinct band of fibrous tissue to indicate their original position. The obliteration generally becomes complete at a variable but early period of intra-uterine life: occasionally it does not occur until after birth. The occurrence of peritonitis is probably in most cases secondary to the blocking of the ducts.

When the lumen of the duct has become so narrowed that the bile does not pass freely into the intestine, a cirrhotic condition begins in the tissues of the liver, and as it goes on interferes with the functions of that organ.

At the post-mortem examinations of these cases the liver usually is found to be much enlarged and its tissues to be increased in consistency: it is of a dark-brown color, owing to the presence of numerous masses of inspissated bile in the smaller bile-ducts. In a large number of cases there is found a complete obliteration of some part or parts of the hepatic, common, or cystic ducts, or of the gall-bladder, while, with very few exceptions, implication of the blood-vessels is conspicuously absent.

In speaking of the explanation which may be given for the occurrence of the symptoms which I have just mentioned, Thompson remarks that the reappearance of the disease in several members of the same family can be explained only by the theory that a congenital defect of development is in these cases the cause of the malformation. The fact that the onset of the jaundice is not contemporaneous with the blocking of the bile-ducts, and usually begins several days after birth, he explains as the effect on the hepatic cells produced by the great changes in the hepatic circulation which occur in new-born infants. The presence of colored meconium in some cases and of only white discharges in others is due to the blocking of the ducts having occurred at different periods of intra-uterine life.

When in combination with the colorless faecal discharges green material is passed during the progress of the disease, this occurrence is probably due to the chemical action on the contents of the intestine, produced in various

ways, one of which may arise if mercury has been administered. The tendency to spontaneous hemorrhages may be due to the occurrence of a condition of chronic blood-poisoning, since the arrest of the outflow of bile damages the liver to such an extent that its functions are interfered with and organic fluids of a poisonous nature may thus pass into the circulation. The enlargement of the spleen, the convulsions, and the vomiting are probably more or less connected with this same condition of blood-poisoning. The fact that the children live as long as they do, and usually do not become emaciated in the early days of life, is to be explained on the ground that the presence of bile in the intestine is not absolutely necessary for digestion. When the nutrition and general health begin to suffer, it is probably due to the interference which the secondary changes in the tissues of the liver are causing with the more important functions of that organ.

**TREATMENT.**—The treatment must necessarily be symptomatic, there being no known means by which we can counteract the results of this malformation.

**CONGENITAL OBLITERATION OF THE INTESTINE.**—I shall merely refer to a malformation which is represented by an obliteration of the intestine. Malformations of this kind may arise from constrictions of the parts affected by fibrous bands, probably the remains of peritoneal adhesions.

**CONGENITAL MALFORMATIONS OF THE ŒSOPHAGUS AND STOMACH.**—Congenital malformations of the œsophagus and stomach are rare, and can best be described in connection with diseases of these parts.

**MALFORMATIONS OF THE HEART AND THE BLOOD-VESSELS.**—I shall defer what I have to say concerning the various anomalies of the heart and blood-vessels until later (Division XVII., p. 1020).

**ASPHYXIA.**—The earliest pathological condition which is brought to our notice at birth, and one which requires immediate treatment, is asphyxia. This condition, which is a failure of the circulatory mechanism to assume its extra-uterine function of oxygenating the blood, endangers the life of the infant from carbonic acid poisoning. It may arise either from mechanical pressure, as from winding of the cord around the neck, from an incomplete expansion of the pulmonary alveoli, *atelectasis*, or from other causes connected with the imperfect oxygenation of the blood, of which we have very little knowledge. In any case the cause, if known, must be quickly removed. This class of cases belongs so directly to the province of obstetrics that it need hardly be more than mentioned in a course of lectures on pediatrics. Prompt measures for performing artificial respiration, as by Credé's method, and the stimulation of the pneumogastric nerve by the application of heat, cold, and electricity, should be borne in mind: they are well described in Dr. Edward Reynolds's work on practical midwifery.

**ACUTE FATTY DEGENERATION OF THE NEW-BORN** (Buhl's Disease).—An affection which has been called acute fatty degeneration of the new-born was described by Buhl in 1861. It is not a disease of common occurrence, and its etiology and pathology have not yet been satisfactorily



determined. Runge, of Dorpat, has written more fully on this disease than any other author, and I am indebted to him for the careful description which he has made of the affection and the literature which he has collected concerning it.

As the anatomical diagnosis can be made only by using the microscope, the disease has probably often been overlooked, and the cause of death ascribed on the one hand to inanition and on the other to such especial forms of hemorrhage in the new-born as omphalorrhagia and melæna. If the numerous causes of hemorrhage from the cord had been more carefully examined anatomically, the disease would probably not have remained so long unknown.

**SYMPTOMS.**—The infants who are affected by this disease are usually born in a condition of extreme asphyxia without any apparent cause for it. Attempts at resuscitation are, as a rule, only partially successful, and at times not at all so, many of the cases dying at once. Diarrhœa is commonly present, and is often accompanied by blood from the rectum. There is sometimes vomiting of blood. Often, after the cord has separated, there may be a parenchymatous hemorrhage, which, although small in amount, is at times sufficient to cause death. There is usually a bluish color of the skin, which changes gradually to yellow or a mixture of yellow and blue. Hemorrhages occur frequently in the skin, the conjunctivæ, the mucous membranes of the mouth and nose, and sometimes the outer ear. Icterus may be present in these cases, and at times may become intense. Sometimes cedema occurs, and without any noticeable rise of temperature there may be a rapid collapse, followed by death, commonly within the first fourteen days of life. These symptoms are not always so well marked as I have just described them. The external hemorrhages may not occur, and the cyanosis, slight at first, may rapidly increase and be followed by sudden death. This sometimes happens so quickly that we are reminded of the conditions which are met with in cases of death by violence.

**DIAGNOSIS.**—A definite diagnosis cannot be made without a careful microscopic examination. The disease must not be confounded with phosphorus or arsenic poisoning, where the organs undergo similar pathological changes. The history of the case and a chemical examination of the organs will enable you to eliminate these other causes of fatty degeneration. The differential diagnosis between this disease and cases of sepsis in which hemorrhages and parenchymatous changes occur is very difficult. Where the vessels of the cord are affected, we must in most cases consider the cause to be septic; where the cases occur in groups, as is seen at times in hospitals or other places where a number of infants are gathered together, this same cause must be suspected; also where putrefactive changes have progressed rapidly in the cadaver we should be inclined to regard the case as one of septic poisoning, as these changes, according to Hecker, do not occur in the specific disease called fatty degeneration.

Fatty degeneration at times simulates so closely the appearances caused



by death from suffocation that its presence becomes a question of great importance from a medico-legal stand-point. The cyanosis, the condition of the lungs, and the ecchymoses, also the absence macroscopically of other organic changes, can easily suggest suffocation. For this reason in all cases of death among new-born children where there is a suspicion of asphyxia, a careful microscopic examination should be made of all the organs.

PROGNOSIS.—The prognosis in this disease is very unfavorable: all the cases in which the symptoms are pronounced die. It is possible that the milder forms of the disease can recover, but as yet we do not know enough about this class of cases to state what proportion of them lives.

ETIOLOGY.—The etiology of acute fatty degeneration of the new-born is very obscure. The disease occurs in animals as well as in human beings, but the investigations made by different observers both on animals and on infants are so varied in their results that we cannot at present consider that we know much about the cause of the disease. It is significant, however, that Buhl in his classic description of the disease states emphatically that the vessels of the cord are not affected, so that if it is due to sepsis the sepsis must have occurred in intra-uterine life through the mouth, the intestinal canal, or the umbilicus, but without producing any change in the umbilical vessels. This can scarcely be considered probable. We know nothing concerning the etiology of this disease, not even whether it is of intra- or extra-uterine origin.

PATHOLOGY.—The pathological conditions which represent the disease consist of a parenchymatous inflammation, followed by a fatty degeneration of the tissues of the heart, liver, and kidneys, and hemorrhages in the various organs. The post-mortem examination of infants dying of this disease, as a rule, shows the following changes. The cadaver is livid and usually icteric. Hemorrhages and œdema are often found in the skin. The umbilicus and the tissues surrounding it are at times stained with blood, but, as a rule, are otherwise normal. The umbilical vessels are in most cases normal. These hemorrhages are especially found in the dura and pia mater, in the pleura and pericardium, and in the connective tissue of the mediastinum: they also occur in the thymus gland, in the peritoneum, in the muscles, and in most of the mucous membranes.

The *brain* is found to be soft, usually full of blood, and, if icterus is present, is stained yellow.

The *lungs* often show hemorrhagic infarction, and in the bronchi bloody mucus or pure blood. The alveolar epithelium is in a condition of fatty degeneration.

The muscles of the *heart* are friable. In the early stages they are rigid and dark red, while in the later stages they become softer and paler. In almost all of them the process of fatty degeneration is found.

In recent cases the tissues of the *liver* are blood-red, while in the later stages they are pale and icteric. The liver-cells contain fat-drops and granules of biliary coloring matter.

The *spleen* is usually found to be enlarged, and its parenchyma is soft and almost fluid.

Hemorrhages may be found in the walls of the *stomach* and *intestine*, and their cavities are often found to be filled with blood.

Multiple hemorrhages are found in the parenchyma of the *kidney*. The cortex is swollen in the early stages, is filled with blood, and is pale and yellowish. The epithelium of the convoluted tubules shows marked fatty degeneration, and the canals are often filled with fatty degenerated material.

The process of fatty degeneration does not in all cases affect all the organs. In some the changes may be absent or a parenchymatous condition may be present.

TREATMENT.—From what I have said concerning this disease you will readily understand that the treatment is usually unsuccessful. Stimulants should be used and the food carefully regulated.

LITERATURE.—You may perhaps like to know the sources (Table 90) from which Runge has obtained his facts in describing the acute fatty degeneration of the new-born.

TABLE 90.

1. HECKER, V., u. BUHL, Klinik d. Geburtskunde, 1861, Bd. i. S. 296.
2. HECKER, V., Monatsschrift f. Geburtskunde, Bd. xxix. S. 321; Bd. xxxi. S. 197; Bd. xxxii. S. 197.
3. HECKER, V., Arch. f. Gynäk., 1876, Bd. x. S. 537.
4. MÜLLER, P., Die acute Fettentartung der Neugeborenen, Handb. der Kinderkrankheiten, von Gerhardt, 1877, Bd. ii. S. 186.
5. COHNHEIM, Vorlesungen über allgem. Pathologie, 2. Aufl., Bd. i. S. 651.
6. HERZ, Oesterr. Jahrb. f. Pädiatrik, 8. Jahrg., 1877, S. 139.
7. RUNGE, MAX, Charité-Annalen, 7. Jahrg., 1882, S. 720 u. 727.
8. FÜRSTENBERG, Virchow's Arch., 1864, Bd. xxix. S. 152.
9. ROLOFF, Virchow's Arch., 1865, Bd. xxxiii. S. 553.
10. ROLOFF, Virchow's Arch., 1868, Bd. xliii. S. 367.
11. BOLLINGER, Virchow's Arch., 1873, Bd. lviii. S. 329.
12. BIRCH-HIRSCHFELD, Handb. der Kinderkrankheiten, von Gerhardt, Bd. iv., 2, S. 707.
13. FRIEDBERGER, FRANZ, u. FRÖHNER, EUGEN, Lehrbuch d. spec. Pathologie u. Therapie d. Haustiere, III. Auflage, 1892, Bd. ii. S. 16 ff.

**INFECTIOUS HÆMOGLOBINÆMIA OF THE NEW-BORN** (Winckel's Disease).—Infectious hæmoglobinæmia is an affection which is met with in new-born infants usually in the early days of life, and, as a rule, arises as an endemic disease in hospitals. The specific micro-organism which produces it has not yet been discovered, yet the fact of its endemic character and the changes which are produced in the blood warrant us in supposing that it is an infectious disease. Although it had been described at an earlier date, yet the most systematic description of it which had appeared up to the year 1879 was that by Winckel, who in that year reported twenty-three cases of an endemic affection observed by him at the Dresden Lying-in Hospital. The disease was characterized by extreme



cyanosis, icterus, hæmoglobinuria, somnolence, rapid collapse, and the absence of fever.

Although in many respects it resembled closely the acute fatty degeneration which I have just described to you, yet it had such characteristic symptoms and conditions of its own that it cannot, until further light shall have been thrown on the subject, be separated from that disease.

I am indebted to Runge for a description of this disease. An analysis of Winckel's cases shows that it usually begins on the fourth day of life, and that it may attack strong, well-developed infants. The course of the affection is very rapid, its average duration being about thirty-two hours. Twenty-five and a half per cent. of all the children born at the time when this epidemic occurred had the disease, and of these nineteen per cent. died.

**SYMPTOMS.**—The first symptoms were generally restlessness and cyanosis, not only of the face but also of the body and extremities, and especially the back. The color increased progressively until it became a deep blue. To this was added an icteric color, which when death did not occur within twenty-four hours became very marked. The respiration was rapid; the pulse was not especially increased in rate. The rectal temperature never rose higher than  $38.1^{\circ}$  C. ( $100.6^{\circ}$  F.). The skin generally felt cool. Vomiting and diarrhoea occurred in some cases. The most striking symptom was the appearance of the urine. It had a pale-brownish color, and was passed frequently, and often with considerable straining. An examination showed that the color was due not to bile, but to hæmoglobin. In the sediment were found numerous epithelial cells from the walls of the kidney, granular casts with blood-corpuscles adherent to them, micrococci, masses of detritus, and urate of ammonia. A small quantity of albumin was present. Later in the disease convulsions occurred, followed rapidly by death. It was noticed that if the skin where the cyanosis was most marked was scratched and then pressed hard, a tenacious, almost black-brown fluid exuded. An examination of the blood showed a marked increase of leucocytes and numerous granules.

In other cases besides those of Winckel's where the blood was examined the condition was found to be one of hæmoglobinæmia. The percentage of hæmoglobin was high, and free hæmoglobin was found in the blood-serum, while the erythrocytes were greatly reduced in number, at times amounting to only 1,700,000 or even less.

**PATHOLOGY.**—A careful post-mortem examination of Winckel's cases showed that there was cyanosis of the external and internal organs. Except in one instance, no pathological condition of the vessels of the cord was described.

The cortex of the *kidney* was found to be wider than normal, to be of a brownish color, and to present numerous minute hemorrhages. In places the pyramids were entirely black-red in color, and in other places numerous black streaks were found which converged to the papillæ. This color was



caused by the filling of the straight tubules with granules of hæmoglobin. Intact erythrocytes were never found.

The *bladder* was found to contain greenish-brown urine.

The *spleen* was strikingly enlarged and hard. Its length was about 7.5 cm. (3 inches), and its weight 25 grammes ( $\frac{5}{8}$  ounce). It was black-red in color, and on section the surface was smooth. Microscopic examination showed a considerable accumulation of brownish coloring matter, partly free and partly in the pulp-cells.

In addition to these appearances in special organs, minute hemorrhages were found in nearly all the organs, but especially in the pleura, pericardium, endocardium, mucous membranes of the stomach and small intestine, and kidney: they were also found in the dura and pia mater and under the capsule of the liver. The lymph-follicles were swollen, especially Peyer's patches and the mesenteric lymph-glands.

A microscopic examination showed fatty degeneration of many important organs, especially the liver, and at times of the muscles of the heart.

The bacteriological examinations were, as a rule, negative, especially as regards the tissues of the intestine. Clumps of bacteria were found only once in the liver and once in the kidney.

ETIOLOGY.—The etiology of this disease is obscure. Winckel had careful examinations made of the organs chemically for poisons, such as phosphorus, arsenic, and chlorate of potash, but with negative results. Examinations in regard to carbolic acid poisoning have also been made in these cases, with negative results.

The resemblance of this disease to acute fatty degeneration of the new-born is very striking. Most of the symptoms are common to both diseases. Larger hemorrhages are also not uncommon in this disease, but are not so marked as in acute fatty degeneration. The striking points of difference are the presence of hæmoglobinuria, and that large numbers of cases are affected at the same time in infectious hæmoglobinæmia, while these conditions have not been found to occur in acute fatty degeneration. In studying the literature of this disease we find a number of observations by different authors. Dr. W. S. Bigelow describes an epidemic at the Boston Lying-in Hospital in which the chief symptoms were a dark color of the skin resembling somewhat that produced by the administration of nitrate of silver, hæmoglobinuria, diphtheritic deposits on certain of the mucous membranes, and dark brown faecal dejections. In this epidemic ten infants were attacked and eight died, the average duration of the disease being five days. In one of these cases phlebitis umbilicalis occurred. Similar cases have been reported by Parrot and Herz in which the urine was brown and strongly tinged with blood and the kidneys and liver showed the condition of fatty degeneration.

Epstein, of Prague, mentions similar cases where prominent features were the thickening of the blood, which made it impossible to get a drop to examine, and the dark brown-red color of the urine. Epstein thinks that

this disease is a septic process which probably starts in the gastro-enteric tract. He believes that he can controvert the apparent absence of fever by the fact that in the diseases of new-born infants great and sudden variations of temperature occur, and in consequence the temperature, for its record to be of value, should be taken very often.

Whether this is so or not, the disease has certain peculiarities, pointing in some cases to an apparent relation with sepsis, and in others to acute fatty degeneration.

The obscurity as to the etiology of the disease has been rendered still greater by the incomplete examinations which have been made of this class of cases, with the exception of those by Winckel and Birch-Hirschfeld.

**TREATMENT.**—The treatment should be the administration of oxygen and stimulants, and forced feeding by means of a dropper where the infant is too weak to suck.

**LITERATURE.**—I have placed in this table (Table 91) the literature which Runge has made use of in his description of this disease.

TABLE 91.

1. WINCKEL, Deutsche Med. Wochenschrift, 1879, Nr. 24, 25, 33, 34, 35.
2. BIRCH-HIRSCHFELD, Deutsche Med. Wochenschrift, 1879, Nr. 36.
3. BIRCH-HIRSCHFELD, Handbuch der Kinderkrankheiten, von Gerhardt, 1880, Bd. iv., 2, S. 702.
4. EPSTEIN, Prager Med. Wochenschr., 1879, S. 343.
5. SANDNER, Münch. Med. Wochenschr., 1886, Nr. 24.
6. STRELITZ, Archiv f. Kinderheilkunde, 1890, Bd. xi. S. 11, and BAGINSKY, Berl. Klin. Wochenschr., 1889, Nr. 8, same case.
7. BAGINSKY, Lehrbuch der Kinderkrankheiten, IV. Auflage, 1892, S. 59.

**HEMORRHAGE IN EARLY LIFE.**—Spontaneous hemorrhage occurring at some period during the early years of life is not uncommon. These hemorrhages may occur either in the skin or from some trifling traumatic lesion, or they may take place in various internal organs, and especially from the mucous membrane of the mouth and the gastro-enteric tract. A definite division of this class of cases has never been thoroughly made, so that the subject has always been somewhat involved in obscurity. The probability is that these spontaneous hemorrhages are simply symptomatic of different specific diseases, and that as our knowledge of these diseases increases we shall find it necessary to make a clear distinction between cases which now are spoken of under one head. The propriety of separating cases of spontaneous hemorrhage which occur in the early days and weeks of life from those which arise later has been shown by Dr. Townsend. He has by a series of observations corroborated the now generally accepted opinion that the hemorrhages which occur in the new-born should be separated from those met with in connection with the hæmophilia of a later period of childhood and of adults. He has called this disease the *hemorrhagic disease of the new-born*. The hemorrhages which occur in new-born infants are so general in their distribution, and yet so uniform in



their general symptoms, that they can well be classed under this one heading. These hemorrhages occurring in the early weeks of life run a definite course, and end in death or in complete recovery. The self-limited nature of this affection corresponds to what is seen in the acute infectious diseases, and suggests a relationship to them. The hemorrhage may arise from the gastro-enteric tract, from the mouth, the nose, or the umbilicus, also from the skin, and in the latter case may show itself in the form of ecchymoses. Again, it may occur in the form of hemorrhages in the abdominal cavity, the meninges of the brain, the pleura, the lung, and the thymus gland.

Dr. Townsend has collected fifty cases of this disease, and has tabulated the sources of the hemorrhage, as follows (Table 92):

Locality.	Cases.
Intestines . . . . .	20
Stomach . . . . .	14
Mouth . . . . .	14
Nose . . . . .	12
Umbilicus . . . . .	18
Ecchymosis in skin . . . . .	21
Scratch of skin . . . . .	1
Cephalhæmatoma . . . . .	3
Meninges . . . . .	4
Abdominal cavity . . . . .	2
Pleural cavity . . . . .	1
Lung . . . . .	1
Thymus gland . . . . .	1
From the gastro-enteric tract, nose, and umbilicus, accompanied by ecchymosis in the skin . . . . .	3
From the gastro-enteric tract alone . . . . .	19
From the umbilicus alone . . . . .	3
From ecchymosis in the skin alone . . . . .	6

The mortality in these cases was 62 per cent. The bleeding first showed itself in all but three within the first seven days of life, the exceptions being on the eighth, ninth, and fourteenth days. The hemorrhage in the majority of these cases began on the second or third day, thirteen starting on the second and sixteen on the third day, while only eight began on the fourth and two on the first day. One-half of the fatal cases lasted one day or less, and all the others died within a week, except one case, in which death took place from the effects of the hemorrhage on the eighth day and several days after the bleeding had ceased. The cases that lived recovered within nine days, and two-thirds of them within five days.

The cases of pseudo-menstruation which occur not uncommonly in the early days of life should not be included in the cases which are classed under the heading of hemorrhagic disease. The *hemorrhagic disease* is apparently a general and not a local one, and is found more frequently in hospitals than in private practice. This fact is well exemplified by comparing the percentage of hemorrhagic cases which occurred among 7225 infants observed in the Boston Lying-in Hospital and its out-patient department. The per-



centage of the disease in the hospital itself was represented by .57, while .10 represents the proportion outside of the hospital. In Townsend's fifty cases the proportion of females to males was as 20 to 30. In four of Townsend's cases the hemorrhage took place in several places as well as at the base of the cord, but the patients recovered and the cord separated, in one case in two days and in the other three in four days after the cessation of the disease, without a fresh hemorrhage occurring.

In fourteen of these fifty cases the temperature was carefully observed, and in all but two was found to be elevated at first from  $38.3^{\circ}\text{C}$ . ( $101^{\circ}\text{F}$ .) to  $39.5^{\circ}\text{C}$ . ( $103.1^{\circ}\text{F}$ .), and in one case to  $40.1^{\circ}\text{C}$ . ( $106^{\circ}\text{F}$ .). After the cessation of the hemorrhages the temperature was normal, and often subnormal.

To recapitulate: it would seem that we are warranted in considering the disease as one of a general nature, and infectious, for the following reasons. (1) It occurs usually in hospitals. (2) It is self-limited in its course, and, although a dangerous disease, may be recovered from in one or two weeks completely and never return. (3) The temperature is raised during the continuation of the chief symptoms, and becomes normal or subnormal when the hemorrhage has ceased.

Ritter at the Prague Foundling Hospital has also noticed a great preponderance of cases occurring in hospital deliveries over those which were met with outside of the hospitals.

In connection with the hemorrhage which occurs in the gastro-enteric tract, the tar-color of the intestinal dejections, arising from the hemorrhage taking place high up in the intestine, is noticeable. The resemblance of the color of the dejections to that of meconium may cause the disease to be overlooked. A slightly pink tinge on the napkin around the dejection is often, however, seen, and where there is a doubt as to whether the stain is from blood or not, it can usually be determined by means of the microscope. Where the corpuscles have become disintegrated, as at times occurs, the hæmin crystals may be recognized by means of a simple test which I shall speak of later. The post-mortem examination which was made in nine of these cases throws no additional light upon the nature of the affection. The source of the hemorrhage was found, but in no case were there any gross lesions of the mucous membrane or the blood-vessels. In all these cases the infants looked very anæmic. In one case cultures were made by Professor Councilman from the blood, with negative results. We do not know what the cause of this disease is, but it is probable that in the great majority of cases it has an infectious origin.

I will now show you a case (Case 185) which is especially interesting, as it shows an unusual result of the blood examination.

The infant is three days old, and presents a blanched appearance of the skin, with stains on the napkin around the intestinal discharges. These stains have been examined in the following way. A drop of the semi-liquid dejection was mixed with a little glacial acetic acid and a few crystals of common salt on a glass slide and heated to boiling. On drying

the preparation and examining it under the microscope, the dark rhombic crystals of hæmin were easily recognized, showing us that we are dealing with a case of hemorrhage taking place probably high up in the intestine. Dr. Wentworth's blood examination gives the following results:

BLOOD EXAMINATION 37. (Wentworth.)	
Erythrocytes . . . . .	6,245,000
Hæmoglobin . . . . .	125 per cent.

The blood spread out very thickly and stained poorly, but the polynuclear leucocytes appeared greatly in excess of the other forms.

The cases which are commonly designated as *melæna neonatorum* should be classed under this heading of the hemorrhagic disease of the new-born, and are represented by this case (Case 185), in which the blood examination was made by Dr. Wentworth. The child died in a few days.

An interesting case (Case 186) of this disease was seen by Dr. Townsend and myself in consultation with Dr. Bush.

A male infant apparently healthy at birth developed on the third day of its life ecchymoses on its head, groins, and one foot. There was also hemorrhage from the upper part of the intestine on the fifth and sixth day, the dejections being tar-colored from altered blood which simulated meconium. On the fifth day the child developed a marked paralysis of the left side of the face, and to a less degree of the left arm and leg, presumably from a meningeal hemorrhage. On the seventh day of the disease the hemorrhage had apparently ceased, as the paralysis was beginning to disappear. On the twelfth day the paralysis of the left arm and leg had improved: there was, however, still some paralysis on the left side of the face, but this did not continue to any great extent, and in the third and fourth weeks decided improvement took place in the child's condition, and there were no longer any evidences of hemorrhage nor any paralysis.

This infant improved rapidly during its first year, and is now living, healthy and strong. It learned to walk and talk rather later than usual, but now at four years of age is in a normal condition both mentally and physically.

I have met with a number of cases in which these hemorrhages occurred and in which they varied greatly as to extent and persistence. The cases in which umbilical hemorrhage was present showed this same tendency to self-limitation, and could be distinguished from those which are classed under hæmophilia. In fact, it is probable that most cases of umbilical hemorrhage are caused by infection and are not especially connected with hæmophilia.

I have here to report to you a case (Case 187) of umbilical hemorrhage in a male which illustrates what I have just said concerning the desirability of separating the hemorrhages taking place in the early days and weeks of infancy from those which occur later and in childhood.

The parents of the infant were well and strong, and were Russian Poles. They had another child, eighteen months old, which was healthy. The mother had never had any miscarriages, and stated that her parents were healthy, as were also those of the father.

The labor was a normal one, the child presenting in the first position, and nothing abnormal was noticed, except that the placental end of the cord continued to bleed quite freely notwithstanding the application of two ligatures. On the day following the delivery the mother and infant were both doing well; the latter showed slight signs of icterus, but



nursed well, and the former had plenty of good breast-milk. The infant continued to thrive, except that there was a slight hemorrhage around the insertion of the cord, which fell off on the eighth day. After the separation of the cord a slight hemorrhage from the umbilicus continued. On the thirteenth day the hemorrhage increased and became so extensive that I was sent for to see the infant. It was then found to be decidedly jaundiced, though not deeply so. It was nursing well, but looked thin and puny. Nothing abnormal was found on making a physical examination. Pale watery-looking blood was oozing from the umbilicus, and quite a large cloth had been soaked with the blood from the umbilicus, giving evidence of a considerable hemorrhage. The umbilicus was plugged with small pieces of lint soaked in perchloride of iron, firmly compressed by a bandage, and alternate drop doses of fluid extract of ergot and tincture of chloride of iron were ordered to be given three times a day.

On the fifteenth day the hemorrhage had somewhat abated, but it was not thought advisable to remove the bandage; the ergot was omitted, on account of nausea and vomiting.

On the sixteenth day the infant was reported to have vomited and cried a great deal, and the plugs of lint had been forced out of the umbilicus, leaving a bleeding surface; the umbilicus was then tamponed with Monsel's solution of subsulphate of iron; the tincture of chloride of iron was omitted, as it caused vomiting. The hemorrhage then lessened and at times ceased.

On the seventeenth day the older child pricked the infant's lip with a pin, and on the eighteenth day the lip was found to be still bleeding. The point of hemorrhage was cauterized with a stick of nitrate of silver. This controlled the hemorrhage for about two hours, when it returned and continued. Compression of the lip finally stopped the hemorrhage on the twenty-fourth day.

On the nineteenth day the hemorrhage had ceased at the umbilicus, and the child continued to nurse well.

On the twenty-ninth day the bandage and lint were removed from the umbilicus, and the abdomen was washed. There was no hemorrhage; the child looked better, and there was not so much icterus.

On the thirtieth day the infant was reported to be perfectly well. It continued to thrive from this time, with no recurrence of the hemorrhage.

On the sixtieth day, although I advised that the operation should not be performed, the infant, in accordance with the Jewish custom, was circumcised. I was present at the circumcision, to see if the hemorrhage would be easily arrested. The circumcision was performed without accident, and the hemorrhage was immediately arrested by a weak solution of iron. From this time there was no hemorrhage, and the child continued to be strong and well.

This case is an instance of the self-limitation of the hemorrhagic disease of the newborn, since, although it was a pronounced case of umbilical and general hemorrhage at the beginning of the infant's life, this tendency had ceased by the end of the second month, as was evidenced by the ready control of the hemorrhage after the circumcision.

In another case (Case 188) which came under my notice the hemorrhage took place from the umbilicus in the early days of life at the time of the separation of the cord, and was completely uncontrolled even by ligatures passed around needles introduced through the skin of the abdomen on either side of the umbilicus. This case eventually recovered.

In none of these cases has a tendency to bleeding developed in later life.

At times we meet with what are apparently very mild cases of this disease. I have here the record of a case which occurred in the practice of Dr. George Haven, with whom I saw it in consultation.

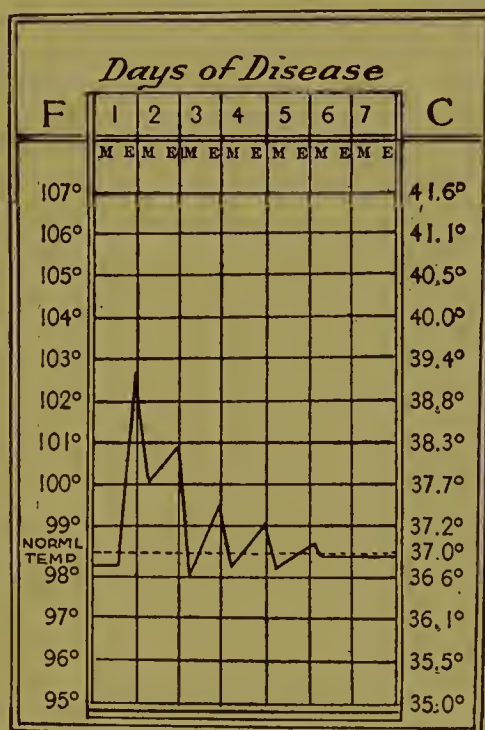
The infant (Case 189), a girl, well developed, and weighing 3358 grammes (about 7 pounds 6 ounces), was born at 12.45 A.M. Nothing abnormal was found on examining it,



and it was perfectly quiet until fourteen hours after its birth, when it began to be very restless. This restlessness continued, and the temperature, which at birth was  $38.6^{\circ}\text{C}$ . ( $101.5^{\circ}\text{F}$ .) in the rectum, began to rise, until at the end of twenty-four hours it had reached  $39.4^{\circ}\text{C}$ . ( $103^{\circ}\text{F}$ .). When it was thirty-six hours old, minute hemorrhagic maculæ were noticed, first on the back of its right hand and arm and then on the right side of its back. A few hours later a number of these maculæ also appeared on the right side of the chest, near the arm. It nursed vigorously, and did not show any signs of weakness, but its respirations were at times quite irregular. From this time no new lesions of the skin appeared, and no hemorrhages from any other locality, the maculæ gradually fading away in ten days. After the first day the temperature fell gradually, and on the fifth day was again normal. Whether there was any loss of weight during the first ten days of life was not known, as it was considered unwise in the infant's precarious condition to weigh it.

Here is the temperature chart (Chart 9), which illustrates what I have already told you in describing the disease,—namely, the rise of temperature, and in favorable cases the return to the normal degree in a few days.

CHART 9.



Hemorrhagic disease of the new-born. Female, 24 hours old.

The cord separated on the tenth day without hemorrhage, and subsequently no abnormal symptoms arose, and the infant continued to thrive during the whole period of its lactation.

**HÆMOPHILIA.**—In contradistinction to the hemorrhages of infectious origin which occur in the early weeks of life is that class of hemorrhages which, as I have already said, can be classed under the term hæmophilia.

Hæmophilia simply means a morbid condition characterized by a tendency to bleed spontaneously or from any insignificant wound. Individuals who are liable to bleed in this way are designated as having a hemorrhagic diathesis. The disease is not especially common in the early weeks of life, and usually occurs at a later period of development. It begins to be more frequent towards the end of the first year, and is apparently well established

in the second year and later in childhood. It does not have a self-limited course, as is the case with the other form of hemorrhage. It is not infectious, and is not accompanied by fever. It may be for many years masked, and then may arise from some trivial cause, such as the extraction of a tooth. It is a dangerous disease, and death is very liable to occur from inability to control the hemorrhage. The disease is hereditary, being transmitted through the females to the males, but seldom occurring in the females, the proportion being one to eleven or thirteen (Osler).

There is no treatment which has been found successful in these cases beyond the active local employment of styptics and compression.

**TETANUS NEONATORUM.**—Although the group of symptoms representing the disease usually known as *tetanus neonatorum*, or *trismus nascentium*, is essentially of a nervous character, yet, as it occurs invariably in the early weeks of life, I have thought it best to speak of it in this connection.

The whole course of the disease, its self-limitation, and the high temperature at the time of its invasion, would naturally lead us to classify it among the other diseases of infectious origin which I have just described to you. The disease usually occurs in infants from the third to the twelfth day of life, and is almost always fatal in two or three weeks.

**ETIOLOGY.**—The cause of the disease is supposed to be the same as that of tetanus in the adult; that is, the *bacillus of tetanus*.

**SYMPTOMS.**—After considerable restlessness and muscular twitching lasting for some hours, the infant assumes a very characteristic appearance. There is extreme rigidity of the legs and body. This rigidity sometimes takes the form of opisthotonos and trismus. The eyes are almost closed, but the infant is sleepless. The trunk and limbs are so stiff that the infant remains in whatever position it is placed in. It is unable to nurse, and has a high temperature, occasionally reaching 40° C. (104° F.), and a pulse of 150 or 160. At times it will have slight convulsive attacks.

This disease is epidemic in tropical climates, but as we see it is usually of a sporadic nature. It is extremely fatal. When recovery takes place the improvement is very gradual, the temperature and pulse decreasing and the rigidity of the muscles passing away very slowly, with at times a recurrence of the symptoms.

**TREATMENT.**—The treatment of this disease has thus far been very unsatisfactory. The possibility of successfully treating these cases with the antitoxine of tetanus must be considered.

The form of treatment which appears to me most rational is to place the child during the continuation of the tonic spasm in a warm bath and to give it .06 gramme (1 grain) of hydrate of chloral every hour until the effects of the drug are shown by the lessening of the muscular rigidity and by a disposition to sleep. In addition to this treatment, small quantities of milk, 15 c.c. (about  $\frac{1}{2}$  ounce), should be given to the infant by means of a dropper every hour, and to each feeding three drops of brandy or some stimulant



should be added. Under this treatment a certain number of cases have been known to live.

I have here a case (Case 190) which was first brought to the hospital two days ago with the following history :

A male, said to have been healthy at birth and to have nursed without difficulty during the first week of its life. It then refused to nurse, apparently from inability to open its jaws. It sometimes cried, but feebly. There were no convulsions, no vomiting, and no rigidity in any other part of the body. The temperature was not taken. On physical examination it was found that, although the infant could swallow, the jaw could not be opened wider than 1.2 cm. ( $\frac{1}{2}$  inch). On forcing the finger between the jaws, nothing abnormal was discovered in the mouth or pharynx. The respiration was regular, but rather shallow, and there was no evidence of injury. Nothing else abnormal was discovered about the infant.

The infant was given .06 gramme (1 grain) of hydrate of chloral three or four times in the twenty-four hours, and to-day shows marked improvement, and, with the exception of still being unable to open the jaws widely, nothing else abnormal has been discovered. The rectal temperature is to-day normal.

The infant has probably passed through the active part of the disease in safety, and it seems likely that it will recover.

This, of course, is not a typical case of tetanus neonatorum, but is one of the milder forms of trismus.

**SCLEREMA NEONATORUM.**—*Sclerema neonatorum* is a disease which occurs in the early days of life, and usually among those who are born in the midst of exceedingly poor hygienic surroundings and in cold weather. It is characterized by a hardening of the skin and the subcutaneous cellular tissue and by a great reduction in the temperature. The tissues continue to grow cooler and harder until death, which occurs usually about the ninth day. It is a rare and exceedingly fatal disease.

It should not be looked upon as a local disease of the skin, but as some obscure constitutional affection of the respiratory and circulatory systems, as shown by the shallow respirations and the diminished activity of the circulation.

**SYMPTOMS.**—Soon after birth, spots of circumscribed hardness appear on the skin. These spots soon become diffuse, and the disease, starting, as it usually does, in the feet or the calves of the legs, passes up the thighs to the trunk. It may, however, first appear upon the face and upper extremities, though not commonly. The skin has a waxy and glistening look, and is hard and cold ; the limbs become thick, stiff, and misshapen. The infant soon grows weak and somnolent, and refuses to take its food ; the breathing becomes rapid and superficial, the voice is weak and whimpering, and the pulse small and retarded. Towards the end of life a discharge of bloody serum from the mouth and nose often occurs, and death takes place seemingly from inanition.

**TREATMENT.**—There is no treatment which has been especially successful in this disease, but the affection should be recognized at once, and energetically treated with inunctions of hot oil and by massage and stimulants.

A number of cases of this disease have been reported in Europe, and



several in this country, notably by Osler. Some investigators think that they have found characteristic changes in the skin. The observations of Northrup, however, who published the first report of a typical case of this kind in America, seem to show that there is no definite lesion of the skin. Northrup made a careful study of his case, and has plainly shown by sections of the skin compared with normal control specimens that the histology of the disease does not reveal any change which can be regarded as characteristic. Dr. Northrup's case embodied every feature of the typical sclerema of the new-born. The infant was a foundling, born in a wretched, damp habitation, and was the weaker of twins. On the fifth day of its life the feet were found to be swollen, and soon began to give on palpation a feeling of hardness like that of a board. This condition soon spread upward to the legs, thighs, hips, shoulders, arms, face, and scalp. The whole body felt as though it were half frozen. The temperature in the rectum was under 35° C. (95° F.). The infant died on the ninth day.

**NÆVUS.**—There are two forms of pathological disturbance in connection with the blood-vessels of the skin which, appearing at birth, constitute a disease called *nævus*. Both these forms can appear on the skin of any part of the infant, but its occurrence is especially unfortunate when it is located on the face.

The first form is very superficial in its distribution, and is the one which is usually called "port-wine mark." This form can in a number of cases be destroyed by the use of electricity. The second form, which is deep in its distribution, as a rule needs to be treated by the knife or the Paquelin cautery. Cases of the superficial form of *nævus* are quite common and vary greatly in degree. A frequent locality is between the eyes at the bridge of the nose, and another is on one of the eyelids. Often in these cases the disturbance disappears of itself after a few weeks or months and does not return. In other cases the lesion remains, often increases, and continues, unless treated, through life. In the second form much can be done by operative interference. This form also varies greatly in size and in the degree of the telangiectasis. In operating on these cases it should be remembered that at times the hemorrhage is great, and that the infants are liable to die from exhaustion. The following case (Case 191) was seen by me with Dr. Lovett:

An infant four months old was born with a superficial *nævus* on the forehead. This *nævus* increased in size, and at four months showed a deep discolored protrusion the size of a half-dollar on the left side of the forehead. Dr. Lovett removed the growth by incisions extending into the sound tissues. There was much hemorrhage at the time of the operation, and after the operation great prostration, apparently from loss of blood. The infant was treated with stimulants and the application of heat; it was fed on a carefully arranged substitute food for a number of days, and finally recovered. At the end of a year all that remained of the original lesion was a very slight scar on the forehead.

## DIVISION IX.

### DISEASES OF THE SKIN.

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#### LECTURE XXI.

IN a previous lecture (Lecture XIII., page 320) I referred to the importance of inspection as a means to be employed in making a diagnosis of diseases in children. The rule that the child should be inspected in every part is especially applicable to the class of cases which I am now about to describe to you.

The lesions of the skin in children differ somewhat from those which occur in adults, and these variations, both in degree and in kind, often make a differential diagnosis more difficult than in adults. Every practitioner has doubtless been struck by the similarity which at times is seen in the cutaneous lesions of the various forms of erythema to those of such diseases as syphilis, scarlet fever, and erysipelas. I have seen in consultation the delicate pink of an abdominal erysipelas in a young infant mistaken so completely for scarlet fever that the precaution of removing the carpet in the room had already been taken. In like manner I have known a slight grade of the efflorescence of scarlet fever to be mistaken for that of erythema neonatorum. I have also seen a harmless papular erythema closely simulating and mistaken for one of the papular efflorescences of syphilis.

Another rule, and one of equal importance, is that no single dermal lesion, whether it be a macule, a papule, a vesicle, or a pustule, makes it justifiable for us to decide that an especial disease is present. We must remember that the same cutaneous lesion may appear in almost any disease, and that it is the combination of dermal lesions and general symptoms which makes up the entire picture of the disease and justifies us in making a diagnosis.

I shall not attempt to speak at length concerning the local diseases of the skin. These diseases come rather within the province of the dermatologist. I wish, however, to show you a few illustrative cases of the more common cutaneous affections which you will meet with in your

practice and will be obliged at least to differentiate from the constitutional diseases with dermal lesions which you will have to treat.

The first case (Case 192) that I have to show you is one which represents the purest type of a primary disease of the skin. It is caused by an especial parasite of the skin, the *Acarus scabiei*.

**SCABIES.**—This child, two and a half years old, is healthy and well developed.

For the last two weeks it has been very irritable, and its mother has brought it to the hospital to inquire about an efflorescence which has appeared on its skin.

On investigating the lesions we find a number of small papules and a few pustules scattered irregularly over the arms and chest, and one or two small pustules on the soles of

CASE 192.



Female, 2½ years old, with lesions of the skin caused by the *Acarus scabiei*.

the feet. The fingers are not especially affected, but in one or two places at the base of the fingers the efflorescence may be plainly seen. In addition to the papules and pustules there are numerous lesions of the skin caused by scratching. Here on the delicate skin of the abdomen is a minute black line with a vesicle at one end of it. On removing carefully with a needle a little of the fluid in this vesicle and placing it under the microscope, you will see the parasite, which evidently had its habitat in the vesicle. This organism, which I shall not describe more fully, as it is best illustrated in your course on diseases of the skin, is called the *Acarus scabiei*, and is the cause of this special dermal lesion. The black line represents the burrow by which it enters and through which it travels as far as the vesicle, where it lodges and produces irritation, causing first a minute papule, and then a minute vesicle. Finally the vesicle may become pustular.

In contradistinction to the effects of the *Acarus scabiei* on the skin of adults we find in



infants and young children that the parasite may attack the soft skin of the soles of the feet, while in the adult we do not find the lesions on the soles, as in walking the skin has become toughened in that locality. In adults efflorescences on the soles of the feet and the palms of the hands are, as you know, rather unusual unless they are connected with syphilis or artificial eczema.

Infants and young children are usually infected by the *Acarus scabiei* from sleeping in the bed with some adult who has scabies. In this case you see that the child's mother shows the lesions of scabies between her fingers.

**TREATMENT.**—In the treatment of this disease it is of course very important to treat it in the mother as well as in the child. The clothes of the bed, of the mother, and of the infant should first be thoroughly steamed, in order to kill the parasite, and it should be impressed upon the mother that the treatment must be carried out very carefully, and that all the clothes which have come in contact with the skin must be thoroughly cleansed.

The treatment of scabies in the child should differ somewhat from that which is employed when the disease occurs in the adult, because the skin of the former is much more sensitive than that of the latter. The severe remedies which can properly be used in treating the adult should not be employed in the treatment of infants and young children.

In this case I shall adopt the method which I have been in the habit of employing, and which was recommended to me by Dr. Bowen as successfully used by him in his practice.

This treatment consists in an application to the skin of this ointment (Prescription 47):

## PRESCRIPTION 47.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
℞ Balsami Peruviani, Petrolati . . . . . āā 60 M.		℞ Balsami Peruviani, Petrolati . . . . . āā ʒii. M.

For an infant as old as this, and for older children, an ointment containing some sulphur could be employed without much danger of irritating the skin (Prescription 48):

## PRESCRIPTION 48.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
℞ Sulphuris sublimati . . . . . 7 Balsami Peruviani, Petrolati . . . . . āā 30 M.	5 0	℞ Sulphuris sublimati . . . . . ʒii; Balsami Peruviani, Petrolati . . . . . āā ʒi. M.

In the use of either of these ointments the following technique should be employed. The child is to be first thoroughly washed with warm water and soap. The skin is then dried, and the ointment is applied over the whole body, avoiding the head, which is seldom attacked by the parasite.

The face especially might be irritated by the ointment. The ointment is allowed to remain on the child during the night, and in the morning is washed off with warm water and soap. The skin is then thoroughly powdered with the zinc and starch powder which I have already mentioned (Prescription 2, page 130). This treatment is continued for three or four days, and then, if the disease is not entirely cured, it can be repeated for a few days more.

A certain amount of eczema usually follows the treatment, owing to the irritation produced by scratching, which is very difficult to prevent. This eczema should be treated by soothing applications.

**PEDICULOSIS.**—A parasite whose nidus is on the head appears quite frequently in children as well as in adults. It is especially met with among the poor and ill cared-for. This parasite, the *pediculus capitis*, causes extreme irritation of the skin, which often results in eczema and in enlarged glands. Although the pediculus itself is in the hair, yet by its irritating action on the scalp of the child it frequently gives rise by reflex influence to patches of eczema grouped about the nose and ears.

**TREATMENT.**—In treating these cases the hair and scalp should first be saturated with petroleum. This application is allowed to remain on the head for several hours, and later is thoroughly washed off with soap and water. The nits should then be carefully removed by means of a fine comb wet with vinegar. It is usually necessary to repeat the treatment for two or three days.

**IMPETIGO CONTAGIOSA.**—I have here two children (Cases 193, 194) who have a parasitic disease of the skin called *impetigo contagiosa*. It is a disease which usually occurs in children, but it may be found in adults. It sometimes appears as an epidemic, and in these cases, in all probability, is caused by the same micro-organism as in the isolated cases. It is usually met with among the poorly cared-for, but it may attack the healthy as well as the sick and weak.

The form of the efflorescence is variable. Beginning as small vesicles, the lesions soon spread over a larger area, coalesce, usually form pustules, and later become rapidly covered with a thick yellowish crust. The lesion may occur on any part of the body, but is especially common on the face and hands. The itching is very slight in these cases, and there is no constitutional disturbance caused directly by the parasite. In accordance with the idea that it is of parasitic origin, the prognosis is favorable, and the disease can usually be cured in a week or ten days.

These boys live in a damp dwelling. They both have lesions on their skin which cannot be explained as those of any of the diseases of which I have previously spoken to you or which I am about to show you.

The first case (Case 193) is nine years old. He has lesions on the arms and on the base of the nose. They are characterized by some yellowish crusts.

The other boy (Case 194) is eleven years old, and was apparently infected by the former. He presents lesions of the same character as in the first case on the end of his nose and on the corner of his mouth.

**TREATMENT.**—The treatment of impetigo contagiosa is very simple, and consists in cleanliness, exposure to sunlight, and the application of an ointment such as this one (Prescription 49):

PRESCRIPTION 49.			
<i>Metric.</i>		<i>Apothecary.</i>	
	Gramma.		
R Acidi borici . . . . .	3   75	R Acidi borici . . . . .	℥i;
Adipis . . . . .	30   00	Adipis . . . . .	℥i.
M.		M.	

**FURUNCULOSIS.**—Closely connected with impetigo contagiosa is *furunculosis*, which is supposed to be caused by the same micro-organisms that give rise to impetigo contagiosa, but which affects a different part of the skin, such as the deeper portions of the hair-follicle, in contradistinction to the upper layers of the skin, the part affected by impetigo contagiosa. These micro-organisms are those which are called the “pus organisms,” and are usually represented by the *staphylococcus pyogenes aureus*.

**TREATMENT.**—The treatment should be with an anti-parasitical ointment or solution preferably containing boracic acid. In many cases in addition to this local treatment some form of constitutional treatment should be employed, as the children are usually in an abnormal condition. The lesions should be bathed every day with this solution (Prescription 50):

PRESCRIPTION 50.			
<i>Metric.</i>		<i>Apothecary.</i>	
	Gramma.		
R Acidi borici . . . . .	15	R Acidi borici . . . . .	℥ss;
Aq. destil. . . . .	240	Aq. destil. . . . .	℥viii.
M.		M.	

After the parts have been thoroughly bathed with this solution an ointment should be spread on linen compresses and applied to the lesions. This ointment should be made in the following way (Prescription 51):

PRESCRIPTION 51.			
<i>Metric.</i>		<i>Apothecary.</i>	
	Gramma.		
R Acidi borici . . . . .	3   75	R Acidi borici . . . . .	℥i;
Petrolati . . . . .	30   00	Petrolati . . . . .	℥i.
M.		M.	

**MOLLUSCUM CONTAGIOSUM.**—Another probably parasitic disease which is rare, but which is more frequent in children than in adults, is molluscum contagiosum. It occurs most commonly on the face, though it may be found on other parts of the body. The lesions consist of small, firm nodules of a whitish color, with a central depression from which matter of a sebaceous consistency may be pressed. The diagnosis is not difficult for one who has once seen the efflorescence, the only condition with which it might possibly be confused being verruca, which, however, does not occur



commonly on the face, has no central depression, and does not contain any substance which may be squeezed out.

**TREATMENT.**—The treatment of these lesions is to puncture them, squeeze out their contents, and dress them with the following anti-parasitic ointment (Prescription 52):

PRESCRIPTION 52.		
<i>Metric.</i>		<i>Apothecary.</i>
	<i>Gramma.</i>	
R Acidi borici . . . . .	3   75	R Acidi borici . . . . . ʒi;
Adipis . . . . .	30   00	Adipis . . . . . ʒi.
M.		M.

**TINEA TRICOPHYTINA** (Ringworm).—The disease called *tinea trichophytina* occurs clinically in two forms. The first form affects the scalp, and is called *tinea tonsurans*. The other form attacks the non-hairy portions of the body, and is called *tinea circinata*.

This little boy (Case 195) has, as you see, two bald spots on the back of his head. The hair over the rest of his head is thick, and there are no appearances of loss of hair

CASE 195.



*Tinea tonsurans*. Male, 8 years old.

anywhere else on his scalp. The areas of scalp attacked by this disease vary in size. In this special case, however, the spots are about 2.5 cm. (1 inch) in diameter. As a rule, they have a fairly regular circumference. On examining the spots you will see that there are little short hairs on their surface, which evidently have broken off from lack of nutrition. On the edges of the spots this is especially noticeable. If you place one of the hairs under the microscope, you will find a specific organism which has been determined to be the cause of this disease. It is of vegetable origin, and consists of masses of spores composed of threads of mycelium, some long and some short, which are divided into numerous segments.

The disease itself is called *tinea trichophytina*, and the parasite which causes it is called the *Trichophyton tonsurans*.

*Tinea trichophytina* has the peculiarity of not appearing on the scalp except in children, but is the same disease that occurs in adults in various

localities, as on the face in men, destroying parts of the beard. It may also occur on any part of the body both in children and in adults. Its cause can usually be traced to the same parasitic affection in some other person or some animal.

**TREATMENT.**—The treatment of this disease should be active, and it is usually necessary to continue it for a long time, especially in cases where the parasite has attacked the head. This ointment (Prescription 53) is a good one to begin the treatment with :

## PRESCRIPTION 53.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Acidi salicylici,		R Acidi salicylici,
Sulphuris . . . . .	aa 3 75	Sulphuris . . . . . āā ʒi ;
Lanolini . . . . .	30	Lanolini . . . . . ʒi.
M.		M.

It should be applied twice daily, and should be thoroughly rubbed into the bald spots, the skin first having been washed with soap and water.

Where the case proves to be somewhat intractable, still stronger applications can be used, and, if necessary, a certain amount of carbolic acid can be mixed with the ointment, from one-half to one drachm to the ounce of ointment.

The second form of *tinea trichophytina*, *tinea circinata*, may at times appear as numerous multiple lesions in different parts of the body, and is easily affected by anti-parasitic applications.

**TINEA FAVOSA.**—The next case (Case 196) represents a parasitic disease called *favus*. Its favorite seat is the scalp, though it may attack any part of the body. It appears in the form of small, bright yellow, cup-shaped crusts, which upon their removal leave a permanent but superficial cicatrix. These yellow crusts penetrate the hair-follicle and destroy the growth of the hair. When placed under the microscope they are found to consist almost entirely of mycelium and spores of the form called *Achorion schoenleinii*. The crusts often become confluent, forming a large thick covering over an extensive area.

**TREATMENT.**—The treatment is the application of an ointment to soften and remove the crusts, epilation, and anti-parasitic ointments such as I have already mentioned (Prescription 53).

**ALOPECIA AREATA.**—On comparing the bald spots on this little boy's head with these on the head of this little girl (Case 197, page 462) you will notice certain differences.

You see on drawing aside her long hair that an irregular surface of the scalp is entirely free from hair up to where the long hair begins to grow on its edges. The appearance of the skin over this spot is normal.

The nature of the disease has not yet been determined. It must be differentiated from this case (Case 195) of *tinea trichophytina* which I have

just shown you, and, as you see, it has an entirely different appearance, the skin looking sound and healthy, while in the case of tinca there are numerous short hairs, which, as I have already explained to you, are broken off through the action of the parasite.

Alopecia areata is somewhat intractable to treatment and runs a rather long course, but, as a rule, in children can be cured.

## CASE 197.



Alopecia areata. Female, 5 years old.

The diagnosis is made by finding a bald spot on the head having the appearance which you see here. The remaining part of the scalp is found to be in a healthy condition and well covered with hair.

TREATMENT.—The treatment is the continual application of stimulating remedies, such as ointments of sulphur and tar (Prescriptions 54, 55).

## PRESCRIPTION 54.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Sulphuris . . . . .	3   75	R Sulphuris . . . . . ʒi;
Petrolati . . . . .	30   00	Petrolati . . . . . ʒi.
M.		M.

## PRESCRIPTION 55.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Olei cadini . . . . .	3   75	R Olei cadini . . . . . ʒi;
Petrolati . . . . .	30   00	Petrolati . . . . . ʒi.
M.		M.

These remedies should be used so as to produce a slight rubefaction, but not inflammation.

PEMPHIGUS NEONATORUM.—In addition to the true pemphigus of adults, the epidemic pemphigus infantilis, and the pemphigus which is



secondary to diseases of a debilitating nature, we at times meet with a form of pemphigus which seems to be caused by a parasite of the skin. Blomberg has reported cases of this kind; one in a girl six days old who had an efflorescence of pemphigus beginning on the lower legs and quickly spreading to the thighs, the abdomen, and the front of the thorax. Later the forearm and head were attacked, but only a few bullæ appeared on the back. The lesions developed quickly on a previously normal skin, and disappeared after a few days, leaving a moist, reddened corium. One of the bullæ on the head was 1.2 cm. ( $\frac{1}{2}$  inch) in diameter. On the right foot one bulla covered all the toes and the sole of the foot. The sole of the left foot was covered by three bullæ. Entire recovery took place. No evidence of an epidemic was found to account for this case. Three servant-girls in the family who took care of the child and who washed its clothes were affected in from three to six days with the same efflorescence on their hands and arms. Another child and the mother had a few bullæ develop on them. Blomberg inoculated himself on the forearm with fluid from the bullæ, and on the following day he was affected with a similar efflorescence, which disappeared in three days.

This class of cases has not yet been fully accepted by dermatologists, and we must remember that on the delicate skin of infants and young children impetigo contagiosa may cause the lesion of pemphigus through the activity of the parasite and the great vulnerability of the skin.

**PEMPHIGUS.**—Pemphigus is a disease of a constitutional character, and is represented by large blebs and bullæ. It occurs at times in infants and children as it does in adults. It is very rare, and I shall not describe it in detail. There is a form of pemphigus, however, which I have met with in infants and children in which bullæ of various sizes appear upon the limbs and trunk, and which is not connected with syphilis. It usually occurs in poorly-nourished children, and can come not only as a disease of itself, but also as one of the sequelæ of debilitating diseases, such as pneumonia, rheumatism, and others. Where it is secondary to other diseases it represents a condition of malnutrition, and in all probability is not connected with the real disease pemphigus. In my experience this class of cases is not especially serious, but merely represents a greater or less degree of lack of vitality of the skin.

**TREATMENT.**—There is no especial local treatment which appears to benefit this condition of the skin, but it soon disappears when the general nutrition of the child has again become normal.

This form of pemphigus, in which the efflorescence is secondary to other diseases, is not usually seen upon the soles of the feet or the palms of the hands, and this is of considerable aid in distinguishing the disease from the bullous form of syphilis.

Where pemphigus occurs as an epidemic among infants in foundling hospitals it is of a more serious nature, and is accompanied by constitutional symptoms, represented by fever, sometimes lasting from three to six

weeks. In these cases it is usually acute, but it may become chronic, and last, with intervals of recurrence, for many weeks or months. These cases are more apt to be fatal than the other forms. The true epidemic form of *purulent pemphigus*, as it has been called, is almost always fatal, and in cases where it is not secondary to any other disease has a grave prognosis. Many of the reported cases of this epidemic form, as well as of the other forms of pemphigus, may really be only manifestations of the staphylococcus invasion.

**DERMATITIS EXFOLIATIVA NEONATORUM** (Ritter's Disease).—In the year 1878 Ritter gave the first complete description of the disease *dermatitis exfoliativa neonatorum*. Previous to this date cases of this affection had been reported, but many of them were regarded as some rare or unusual manifestation of pemphigus. Ritter studied and reported the cases which he saw at the Foundling Asylum in Prague from 1868 to 1878. A careful review of Ritter's original observations of these cases has been made by Elliot, to whom I am indebted for what I have to tell you concerning this rare disease. The majority of cases were in male infants, and the mortality was found to be 48.82 per cent.

The disease occurred rarely before the end of the first week, and usually appeared between the second and the fifth week, of life. It was found to vary greatly in the intensity of its symptoms. In some cases a dry scaly condition of the skin preceded the subsequent lesions, which had apparently lasted after the physiological desquamation of the epidermis had taken place.

**SYMPTOMS.**—The first symptom noticeable in these cases was a diffuse redness, usually over the lower half of the face about the mouth, sometimes, however, beginning in some other portion of the body, and at times being universal from the beginning. This hyperæmia of the skin spread rapidly, and in a few days became universal, the extremities, as a rule, being the last parts affected. The mucous membrane of the mouth and nose was at times affected, and the conjunctivæ usually participated in the hyperæmia. The color of the efflorescence varied from a light to a dark purple-red. As the hyperæmia extended to new surfaces, those which were first affected began to desquamate. This desquamation at times gave no evidence of exudation, the epidermis being simply thickened, and the loosened epithelium separating easily. At times other lesions appeared, such as milia, and sometimes the horny layer of the skin was raised above an intensely reddened base, and large, irregularly-shaped bullæ filled with fluid were formed. After the desquamation had taken place the skin recovered its normal condition, sometimes very rapidly, but it remained for some time rough and irritable. In the cases where there was no exudation a longer time was necessary for the separation and regeneration of the epithelium.

Usually the disease was found to run its course in from seven to ten days. Relapses were sometimes observed ten or twelve days after the first attack, but were always mild.



In typical cases the process was unaccompanied by any fever or systemic disturbances unless some complication existed. The functions were normal, and the weight of the infant remained stationary or was even at times increased. The fatal cases resulted either from the intensity of the attack or from some intercurrent affection or sequela, such as furunculosis. The disease is usually recognized as a local septic infection of the skin, and it would seem that it should be distinguished from the pemphigus which occurs in the early weeks of life.

I have myself seen but one case in which it seemed that this diagnosis of dermatitis exfoliativa could reasonably be made.

This case (Case 198), a male infant, at the fourth or fifth day of its life presented a marked condition of erythema neonatorum. After a few days this erythema began to desquamate slightly, but somewhat later a pronounced dermatitis appeared and ran its course for a week. During the course of the disease there were lesions of various kinds represented by a few pustules and bullæ, but mostly by an intense erythema. The lesions gradually grew less intense, a profuse desquamation took place, and the skin then presented a normal appearance. During the course of the disease the infant did not show any constitutional symptoms, and gained somewhat in weight. The parents were healthy, strong people, with good hygienic surroundings.

I shall now speak of some of the more simple forms of dermal lesions which frequently occur in infants.

**ERYTHEMA.**—Erythema plays an important part in the diseases of infants and young children. Although it is one of the most common and readily diagnostic diseases of the skin which occur in early life, yet at times it is quite difficult to differentiate it from other diseases, owing to the variety of its forms. It may be divided into two broad classes: (1) the congestive form, or *erythema simplex*, which is caused by traumatism and by various drugs, and is also symptomatic of the acute exanthemata; (2) the inflammatory form, *erythema multiforme*, which may affect any part of the body and either small or large surfaces. It has, however, a predilection for the backs of the hands and of the feet. Its lesions may be represented by maculæ, or in the process of its evolution these maculæ may develop into maculo-papules, vesico-papules, papules, vesicles, and even bullæ. The lesions vary in size. The color varies from bright red to purplish red, and is sometimes very vivid. The delicate texture of the skin of young subjects is more likely to show variations in the color and the form of its lesions than is the fully developed and stronger skin of the adult.

**SYMPTOMS.**—The symptoms of the congestive form are varied, and they do not accompany each manifestation of the disease with any especial regularity. The slightest local irritation, whether from parasites or trauma of any kind, changes in temperature, reflex irritation from the close connection between the digestive organs and the skin, and many other reflex manifestations, may produce the disease.

In erythema multiforme there may be pains in the joints simulating rheumatism, malaise, slight fever, nausea, coated tongue, loss of appetite, and



a swollen, tender skin. These more marked symptoms are, however, often absent, and the lesions of an erythema multiforme commonly appear on the skin of young subjects without any especial general symptoms accompanying them. It is better in your nursery practice not to endeavor to classify this protean disease under special names which have been handed down from time immemorial in the text-books, and which have no particular significance. These names have been used indefinitely by physicians, and the same form of lesion is sometimes called by one name and sometimes by another.

TREATMENT.—The treatment of all forms of erythema is practically the same. It consists chiefly in the application of a simple powder (Prescription 56) of oxide of zinc and starch, and of a lotion consisting of either lime water or rose water in which calamine and oxide of zinc are suspended (Prescription 57).

PREScription 56.

<i>Metric.</i>		<i>Gramma.</i>	<i>Apothecary.</i>			
℞	Zinci oxidi . . . . .	7	5	℞	Zinci oxidi . . . . .	℥ ii;
	Amyli tritici . . . . .	60	0		Amyli tritici . . . . .	℥ ii.
	M.				M.	

S.—For external application.

PREScription 57.

<i>Metric.</i>			<i>Apothecary.</i>		
		Gramma.			
R	Zinci oxidi,		R	Zinci oxidi,	
	Calaminæ præparatæ . . . . .	āā 7 5		Calaminæ præparatæ . . . . .	āā ℥ii;
	Aquæ calcis . . . . .	240 0		Aquæ calcis . . . . .	℥viii.
	M.			M.	

S.—For external application.

ERYTHEMA INTERTRIGO.—The form of erythema which is called intertrigo I have already referred to in my lecture on nursery hygiene (Lecture V., page 112, Plate III., A), and I showed you a case (Case 42, page 132) of this disease at the time that I was explaining the proper way to preserve the infant's skin from irritation. I shall, therefore, not speak any more in detail concerning this condition, but shall merely state that it should be classified as belonging to the congestive form of erythema.

In the more severe forms of this disease, where the erythematous condition has become eczematous, and where the skin in the folds of the groins, of the neck, or of the axillæ shows fissures and the moist condition represented by eczema madidans, I have found an application of boracic acid powder quite efficacious.

ERYTHEMA NODOSUM.—Another form of erythema, called *erythema nodosum*, is a disease which is closely allied to erythema multiforme. The general characteristics and symptoms of erythema nodosum can be well learned by studying the case of this child who has been brought to my clinic for examination.

She is a little girl (Case 199), five years old, and until two days ago was perfectly well. At that time she began to have loss of appetite, fever, and malaise, followed by pain in both her legs. Following these general symptoms this efflorescence appeared in various places on her legs. You will notice it above and below the knee, but mostly over the tibia and extending down as far as the ankle. These lesions vary from 1.2 to 2.5 cm. ( $\frac{1}{2}$  to 1 inch) in diameter, and are of a somewhat irregular elliptical outline. They are of an erythematous type and have a delicate pink color. The skin over these lesions is hot in comparison with the unaffected portions of the skin around them. The lesions are tender on pressure, and their tissues are somewhat indurated, so that the feeling is that of a hard, raised swelling.

The disease is self-limited, but is irregular in its course. It usually disappears in about two weeks. Its cause is not known. The treatment is simply palliative.

**URTICARIA** (Nettle-Rash, Hives).—The term *urticaria* has been applied to an efflorescence characterized, as a rule, by wheals, which appear suddenly and disappear quickly. It is accompanied by intense itching and burning, and may show itself on any part of the skin, in lesions either small or large in number.

It is commonly caused by irritation of the gastro-enteric tract. The disease may end in two or three days, but usually lasts for some weeks, and may become chronic; it is essentially, however, an acute affection.

If the lesion has been severe there may be slight desquamation, but this is rare. Sometimes there may be only one attack; again there may be relapses, and in some forms and in certain skins it may occur from year to year.

When seeking for the cause of an outbreak of urticaria you must investigate carefully as to whether there has been an error in diet. In children some simple article of food may cause an urticaria to appear, just as in some adults the disease occurs from an idiosyncrasy which prohibits them from eating oysters, lobsters, strawberries, or certain other articles of diet. Again, in some individuals certain drugs, such as chloral, bromide of potash, chlorate of potash, and belladonna, may cause the dermal lesions of urticaria. The wheals of urticaria frequently occur as a symptom in the course of various diseases, such as scabies, or may be caused by the bites of insects.

**TREATMENT.**—The treatment should be directed first to the removal of the cause of the dermal irritation. When this cause has been removed the dermal lesions will, as a rule, disappear, unless still further irritation has been produced by scratching the lesion or by its being too severely treated by the physician.

The diet should be milk for a time, and experiments should be made with different articles of food to see which one may cause this especial form of irritation. The bowels should be carefully regulated. The local applications consist in remedies to relieve the itching and burning, in the wearing of unirritating clothing and soft linen next the skin, and in a powder of starch and zinc, made as I have already described to you (Prescription 57), frequently applied to the lesions at intervals during the day. Where the itching is extreme, anti-pruritic lotions and ointments should be applied, such as the following (Prescriptions 58, 59, page 468):

## PRESCRIPTION 58

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
℞ Pulv. calaminæ . . . . .	7   5	℞ Pulv. calaminæ . . . . . ʒ ii ;
Aq. calcis . . . . .	240   0	Aq. calcis . . . . . ʒ viii ;
Acidi carbolici . . . . .	1   87	Acidi carbolici . . . . . ʒ ss.
M.		M.

When this lotion is not sufficient to allay the irritation and where the burning is extreme, this ointment (Prescription 59) can be used :

## PRESCRIPTION 59.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
℞ Menthol . . . . .	0   6	℞ Menthol . . . . . gr. x ;
Adipis . . . . .	30   0	Adipis . . . . . ʒ i.
M.		M.

I have here a little boy (Case 200), sixteen months old, who has been brought to the hospital for advice concerning these lesions on his skin. The mother gives the following account of the case.

A woman who had been taking care of him, and beside whom he had slept at night, was attacked with facial erysipelas of a rather severe type. The mother was exceedingly worried at this occurrence, and consulted her physician as to the probability of her infant's having contracted erysipelas. She was assured by the physician that it would be unlikely for infection to take place under these circumstances.

This was two days ago, and to-day she says that early this morning the infant was found to have considerable fever, to be vomiting, to feel dull, and to seem quite ill. While holding the infant in her lap she noticed that there was a red appearance of the skin covering its right knee, and another member of the household, who considered that she had a great knowledge of diseases in children, announced to the mother that the infant had erysipelas: the mother at once supposed that it had contracted it from the woman who had facial erysipelas.

On examining the skin you will see that the knee and the upper part of the lower leg are swollen and of a vivid red color. On touching it we find that it is not painful, but that the skin is hot, and that there is considerable swelling of the tissues. The infant's temperature is 40° C. (104° F.), its pulse 150, and it looks as though it were suffering from some grave constitutional disease. The color of the efflorescence is identical with that which we at times see in cases of erysipelas, and this fact, in connection with the constitutional disturbance, would make the mother's supposition that her infant had an attack of erysipelas a reasonable one.

I have already impressed upon you the rule that we should examine the entire skin before making a diagnosis of any special disease connected with it. I shall, therefore, although it is highly probable that this is a case of erysipelas, investigate the case still further.

Now that its clothes are removed you see that there is no other dermal lesion on the infant's front, but on looking at its back you will see a number of lesions, some papular, others papulo-vesicular, and here, just below the right scapula, you see a wheal. The infant also shows evidence of irritation from the way in which it endeavors to scratch. These lesions on the back are evidently not those of infantile erysipelas, and on looking again at the original source of disturbance you will notice that instead of the diffuse redness so closely simulating erysipelas, which you saw a few minutes ago, there is now an efflorescence gradually fading away and becoming lighter in color.

This change in the appearance of the efflorescence, in connection with the very evident lesions of urticaria on the infant's back, leads me to defer making a diagnosis until I have questioned the mother still further concerning the infant.

She now tells me that yesterday the infant had been taken care of by a friend, who allowed



it to eat some unusual articles of food. We can, therefore, account for the vomiting, loss of appetite, malaise, and fever by a disturbance of the digestive organs.

I can now readily make the correct diagnosis, which is very evident, and which would have been impossible if we had only seen the efflorescence as it occurred on the knee and at the time when we first saw it. It is a typical case of one of the more severe forms of urticaria.

The next case (Case 201) is a little girl, six years old. There is no history of constitutional disease in either of her parents. The mother states that she has had no miscarriages. The child is said to have been a healthy infant, to have had no diseases, and to have been well until six months ago. She then began to complain of frontal headache and to be slightly feverish at night. Her appetite grew poor, and she lost in strength and weight. She has had no cough. She is slightly anæmic and decidedly nervous. She sleeps well, but the bowels are constipated. Nothing unusual has been noticed about the urine. She complains of palpitation and dyspnoea on exertion. There have been no articular or muscular pains. A few weeks ago an efflorescence attended with much itching appeared first on her legs and then on her back and face. The soles of her feet and the palms of her hands were not affected. The efflorescence consisted of macules, at times wheals, evanescent from day to day, and, as you see, irregular in their distribution. At times the lesions have been maculo-papules in certain areas, and also papules.

An examination of the chest shows the lungs to be normal. The cardiac area of dulness is normal. There are no continuous cardiac murmurs. There is slight irregularity of the cardiac rhythm, and a sharp ring to the cardiac sounds, especially the second pulmonic sound. At times also there is a soft evanescent murmur heard over the base of the heart.

On closer examination of the efflorescence we find on drawing the finger gently over it that the pink color disappears, showing that the macules are caused by a congestion of the blood-vessels supplying these areas of the skin. We therefore are not dealing with a constitutional condition such as purpura, which would have resulted in a rupture of these vessels, and which also would have been free from itching and darker in color.

The mother naturally asks, what is this disease which so disfigures her child's appearance. What shall we tell her? In the first place, I have inquired about the child's diet, and have found that it has not been a nutritious one. What, however, especially struck me was that the child has had for the past year a diet consisting largely of tea. We can at once, then, account for her general condition on the supposition that she is an inveterate little tea-drinker. Her failure in general health, her headache, nervousness, and occasional cardiac murmurs, all correspond to the history of tea-poisoning.

We can now with these facts obtained from the general history of the case diagnosticate the efflorescence which plays so great a rôle in the child's case, for it is the rash for which the mother has brought her for treatment. The general appearance and description of the case permit us to eliminate in our diagnosis the various efflorescences occurring in the course of scarlet fever, measles, and varicella. The absence of hemorrhage, as I have already stated, precludes purpura. The absence of heat, of pain, of swelling, and of induration of the subcutaneous tissues allows us to eliminate erythema nodosum. The evanescence of the macules and the great irritation enable us to state that we have not a syphilitic erythema to deal with, for, as a rule, the macules of syphilis do not itch. The appearance and description of the lesions are not those of eczema. In a word, you have before you a case of urticaria.

As to the cause of the urticaria, we must remember that certain drugs, which I have already referred to, may produce appearances of this kind on the skin, and the close reflex connection between the delicate terminal filaments of the nerves of the stomach and the skin may cause a great many disturbances, among which are irritation of the gastric membrane and a resulting indigestion.

In addition to tea and improper food, I find that the child has had quite large doses of tincture of chloride of iron given to her. This preparation of iron is a valuable one, and was given for the child's anæmia, but in young children it often is of itself a cause of gastric irritation such as is represented in this child. It was, therefore, especially as the child was constipated, not indicated in her case.

In this class of cases I think that it is best not to give iron at first, but to allow the stomach to recover itself by regulating the diet. I shall treat the child with a milk made slightly alkaline with lime water, and with thin soups and bread one day old. I shall exclude from her diet tea, pastry, and fried foods of all kinds. Later I shall allow her to have a more laxative and less irritating form of iron, such as this (Prescription 44, page 391).

Under this treatment, combined with freedom from excitement, baths, and plenty of fresh air, I can, from my previous experience with such cases, safely promise the mother that the child will improve, become strong and rosy, and soon be relieved from her unfavorable symptoms.

**ECZEMA.**—Eczema is a disease of the skin which plays a much greater rôle in infancy and early childhood than in any other period of life. It is one of the lesions of the skin which should be placed in the hands of a dermatologist. It is so difficult to cure that it must always be looked upon as a grave disease. You should, therefore, even in the slight and insignificant forms of eczema, be careful not to give a favorable prognosis until you have treated the disease for some weeks, for at any time it may extend to new areas of the skin. I shall not attempt to give more than a very brief description of it.

It is essentially a form of dermatitis, and we may find the same lesions appearing in cases which have been exposed to certain vegetable poisons, such as the rhus toxicodendron, to various artificial irritants, or to extremes of temperature.

Before speaking of the general treatment of these cases which we adopt in the hospital, I shall show you a few of the cases that have come under my care.

CASE 202.



Eczema capitis.

Here is an infant (Case 202) in whom the lesions on the skin are confined to the head and face.

These lesions consist of papules, pustules, crusts, some excoriated patches caused by scratching, and a thick rather oedematous condition of the skin, especially around the lips, nose, and eyes. The hair has been cut off, and you see various lesions on the scalp: in eer-

tain parts of the scalp you will notice a reddened moist condition, which represents what is called eezema rubrum. This is the same ease as the one (Case 48) that I showed you at a previous leecture (Leecture V., page 143) as representing bow-legs. He has returned to the hospital with a recurrent eczema of the face and head.

The treatment of this ease is as follows. The crusts and the thickened tissue of the face and scalp will first be softened by means of a poultice. After the larger crusts have been removed, the mask, which I have already shown you (page 143), will be applied to the face and scalp. The inner surface of this mask is thickly spread with this ointment (Prescription 60):

PRESCRIPTION 60.

<i>Metric.</i>			<i>Apothecary.</i>
		Gramma.	
℞ Unguenti zinci oxidi,			℞ Unguenti zinci oxidi,
Lanolini . . . . .	ãã 30	00	Lanolini . . . . . ãã ʒi.
M.			M.

ECZEMA UNIVERSALE.—The next case (Case 203) which I have to

CASE 203.

I.



Eczema universale. Female, 5 years old.  
I. Before treatment.

show you is one that is being treated for an eezema which has attacked the face, head, trunk, and extremities of a little girl five years old.



You see on examining her naked that almost every form of eczema is represented in some part of her skin. Here on the right lower arm and the upper right leg we have a form of eczema rubrum; that is, an intensely reddened and moist surface. On the left upper leg are numerous papules, representing the papular form of eczema. On the backs of the hands and upper surfaces of the feet are some spots, which represent the macular form of eczema. On the trunk, lower legs, upper arms, face, and scalp is a collection of thick crusts, representing the form which is called eczema impetiginosum. There is such intense itching connected with this form of eczema that the child is continually scratching its skin and making the disease worse. You must remember this fact, because scratching for a few minutes may retard the recovery of an eczema for many weeks, and therefore it is of the utmost importance for the success of the treatment of a case of this kind, as well as of any of the milder and more local forms of eczema, absolutely to prevent the child from scratching. This can in such cases as are here represented be accomplished only by the complete control of the child's movements.

We should first endeavor to allay the itching by means of applications to the whole skin, and secondly to bandage the child in such a manner as to make any attempt to scratch impossible. I will have this child while you are here in the ward treated by the method by which we are accustomed to control and almost invariably cure this disease.

## CASE 203.

## II.



Eczema universale. II. Treated by complete rest.

The child is covered from head to foot with soft cotton cloth eompresses thickly spread with the ointment which I have just mentioned (Prescription 60).

It is then placed in this position on its back in bed, and broad straps are drawn across its legs, abdomen, chest, and shoulders, thus completely binding its arms to its sides and keeping the legs in extension. On either side of the head are placed soft, heavily padded sand-bags, which prevent it from moving its head from side to side and thus by rubbing irritating the eczema of the face.

It is necessary to have a nurse in continual attendance, in order to soothe the child, and by amusing it in various ways induce it to forget what at first may be a rather uncomfortable position. This feeling of discomfort usually soon passes away.

This is not a cruel form of treatment. The irritation is soon relieved when the child is kept quiet and prevented from scratching. If necessary, in the early hours of the treatment some drugs of a soothing nature may be given to prevent an undue nervous condition of

the patient. The nurse should be instructed to be very gentle with it, and continually to divert its mind from its skin. Under this treatment in a few days the eczematous condition of the skin will improve and the itching will diminish.

(Subsequent history of the case.) You remember the case (Case 203) of universal eczema which I showed you at a previous lecture being treated in bed. It had improved so much within two weeks that it was allowed to be out of bed and dressed, and to have the ointment applied merely on its face and head (III.).

CASE 203.

III.



IV.



Eczema universale. III. Three weeks after beginning of treatment. IV. Four weeks after beginning of treatment.

You see that the skin of the trunk and extremities is almost entirely well. The face also is in a much improved condition, and during most of the day she is allowed to have the face uncovered and the ointment and bandage applied to her head only (IV.). I hope in a few weeks to be able to omit entirely the application of the mask to the face and of the bandages to the head.

The eczema in this class of cases is very apt to recur.

It is often asked by the mother and nurse whether the eczema of infants is contagious. I have seen instances where the nurse who was taking care of a case of eczema in an infant had an eczema develop on her hands. This

was apparently caused by the nurse having washed the infant's napkins. The hands of the nurse were cured by local treatment, and by using rubber gloves in washing the napkins she did not again contract the eczema. Cases of this kind give rise to the idea that eczema is contagious, but the probability is that they are simply cases of artificial dermatitis caused by irritating substances of various kinds, and that there is no especial germ which causes eczema. We can, therefore, say that the disease is not contagious, and that simple cleanliness and protection of the hands by means of rubber gloves are all that is necessary to prevent the disease being contracted.

I might mention that in this class of cases of universal eczema other applications besides that which I have mentioned may often be useful, though in my experience and in that of Dr. Bowen there is no one applica-

## CASE 204.

I.



II.



Torticollis from enlarged and tender cervical glands in eczema universale. I. Glands enlarged and tender. II. Glands reduced in size and not tender. Female, 6 years old.

tion which is suitable for all cases, and it is rather the details of applying the remedy, keeping the child quiet, and thus allowing the skin to recover its vitality, that constitute the important part of the treatment. Where the eczema is of a simple erythematous type, with slight itching, an application



of some powder such as this one (Prescription 57, page 466) is often useful,—the child being placed between two sheets and thoroughly dusted with the powder, while a nurse is in constant attendance to prevent scratching.

There is one interesting form or rather complication of universal eczema a case of which I happen to have here in the wards to-day to show you.

This little girl (Case 204) came to the hospital to be treated for torticollis. The head was drawn to the left side as she now shows you (I.), and she could not straighten it. This condition had lasted for many months.

On examining the child I found that she had the usual universal eczema of a chronic type affecting the head, face, and extremities. On examining the neck I found a number of enlarged tender glands. These enlarged glands were evidently caused by reflex irritation from the eczema, and were the cause of the torticollis.

She was treated with the ointment which I have just described to you (Prescription 60, page 471), and the usual bandage and mask, and to-day, although the eczema is not yet cured, the irritation in connection with it has been so much lessened that the glands of the neck have gradually subsided and have now disappeared, and the child, as you see, is able to hold her head straight (II.).

I expect the child to receive still further benefit from the treatment, and that she will be discharged from the hospital cured.

In addition to the forms of eczema of which I have already spoken, you will meet with many instances of a local eczema which has been produced by some irritation either at or near the place affected, or perhaps in some entirely different part of the body. This is usually called *reflex eczema*. An example of this form of eczema is where the irritation is on the scalp, such as occurs from pediculi, and develops a local reflex eczema on the back of the neck.

**PSORIASIS.**—This little girl whom I shall now show you has certain lesions on her back which it will interest you to examine. These lesions are characteristic of the disease called *psoriasis*. Nothing is known of the real cause of psoriasis. So far as we can ascertain, it is not dependent on any micro-organism. When the disease is well developed the diagnosis is very simple, and its lesions correspond, as a rule, to those which are commonly met with in the adult. It begins with small papules, which almost immediately become covered with scales. These scales have a pearly white color, and on removing them we find a bleeding surface, showing that they are more closely connected with the corium than is the case in other diseases where desquamation takes place, such as dermatitis or scarlet fever.

The efflorescence of psoriasis is general, and is, as a rule, marked on the elbows and knees, for in these places the lesions coalesce and the scales are especially thick.

I have noticed in the psoriasis of children that the type of the disease is often so mild that we can scarcely believe we are dealing with the same affection that we are accustomed to see in the adult. In some cases a few lesions scattered here and there, especially on the back over the scapulæ, will be all that represent the disease, and will be easily cured, even

disappearing of themselves in a few months. Besides affecting the trunk and extremities, the efflorescence may occur on the scalp, especially along the edge of the hair on the forehead, but the disease is not very common on the face. Psoriasis is apt to recur even at intervals of years, so that we cannot say that it can be absolutely cured, though at times it may disappear under treatment and never return.

This child (Case 205) has had the disease once previously, and returns to the hospital for additional treatment.

The lesions, as you see, vary in size, and in this case are rather small, being only about 5 em. ( $\frac{1}{4}$  inch) in diameter. Many of them are still smaller. You see what an almost regular outline they have, and how in the centres of many of them are the characteristic small, pearly white scales which at once enable us to diagnosticate the disease. Where these scales are not present, as sometimes occurs in the early stages of the disease, it is much more difficult to make the diagnosis.

The disease is not accompanied by any constitutional symptoms, and, as a rule, there are no local symptoms, such as pain and heat. On palpation you find the spots to be accompanied by more or less induration of the surrounding tissue.

**TREATMENT.**—The treatment of psoriasis in children should be milder in its form than that which you would employ in treating the adult. In this case I shall have this ointment (Prescription 61) of ehrysarobin applied to the lesions in the evening and washed off with soap and water in the morning, there being no treatment during the day.

PRESCRIPTION 61.			
<i>Metric.</i>	<i>Gramma.</i>		<i>Apothecary.</i>
℞ Chrysarobini . . . . .	0   60	℞ Chrysarobini . . . . .	gr. x;
Petrolati . . . . .	30   00	Petrolati . . . . .	℥i.
M.		M.	

This ointment stains the skin, but not permanently. It should never be applied to the face or the scalp, and should be used with great care, as it causes on some skins considerable irritation, and at times a severe dermatitis. With ordinary caution, however, this need not occur.

In intractable cases where this milder form of ointment is not efficacious, the strength may be increased to 1 or 1.5 grammes (15 or 20 grains) to the ounce.

You should remember that ehrysarobin stains the clothes black indelibly, so that old sheets and night apparel should be used while the treatment is being carried out.

In place of this ointment you can use on especially irritable skins, or on the face and scalp, this preparation (Prescription 62) of sulphur and tar :

PRESCRIPTION 62.			
<i>Metric.</i>	<i>Gramma.</i>		<i>Apothecary.</i>
℞ Sulphuris . . . . .	3   75	℞ Sulphuris . . . . .	℥i;
Olei cadini . . . . .	1   87	Olei cadini . . . . .	℥ <sup>ss</sup> ;
Adipis . . . . .	30   00	Adipis . . . . .	℥i.
M.		M.	



Psoriasis. Female, 9 years old.





I have here another case (Case 206) of a boy now seventeen years old, who first came under treatment for psoriasis when he was seven years old.

Under the usual treatment the efflorescence disappeared and the child was apparently

CASE 206.



Recurrent psoriasis. Male, 17 years old.

cured. The lesions, however, have reappeared from time to time, and come and go without reference to treatment. The lesions which you see on his back are much larger than those which you saw on the girl (Case 205). They vary from 2.5 cm. to 5 cm. (1 to 2 inches) in diameter, and have a thick, irregular outline.

**PRURIGO.**—Prurigo occurs in two forms in infants and children,—(1) *prurigo mitis infantilis* and (2) *prurigo ferox*.

(1) **PRURIGO MITIS INFANTILIS.**—Prurigo mitis infantilis occurs in infants two or three months old, and may last for some years.

**SYMPTOMS.**—It begins with little nodular infiltrations, especially marked on the anterior surface of the extremities, and is accompanied by great

itching. It may appear on the face. It does not lead to an infiltration of the skin or to the formation of pus.

**TREATMENT.**—The treatment consists in remedies to relieve the itching and allay the eczema with which it is usually complicated.

It is closely allied to papular erythema, but is more chronic and has a greater tendency to recur. It is very rare in America.

(2) **PRURIGO FEROX.**—Instead of this mild form a more severe type of prurigo occurs at times. This latter form is far more serious in its symptoms and in its prognosis, and may continue through life. The disease, which is characterized by the same dermal lesion as that just described, is progressive from the beginning; it usually starts on the legs, and the skin becomes thicker as it descends. The efflorescence is accompanied by enlarged glands, especially in the inguinal region.

The disease is rare in America, but is common in Germany.

Its etiology is very obscure, and it is a most intractable chronic affection.

**TREATMENT.**—The treatment is palliative.

For the extreme itching caused by the papules an application of this ointment (Prescription 63) may be used :

**PRESCRIPTION 63.**

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
℞ Unguenti diachyli, Petrolei . . . . . āā 30 M.	00	℞ Unguenti diachyli, Petrolei . . . . . āā ʒi. M.

S.—To be applied on flannel three times a day for ten minutes, and to be followed by the application of this ointment (Prescription 64) :

**PRESCRIPTION 64.**

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
℞ Unguenti diachyli, Petrolati . . . . . āā 30 M.	00	℞ Unguenti diachyli, Petrolati . . . . . āā ʒi. M.

If there is much infiltration, *sapo viridis* should be applied at night and washed off the next morning. It must, however, be used with caution, as it is very irritating.

**HERPES ZOSTER.**—I have here two cases (Cases 207, 208) to show you,—a boy and a girl. They represent the disease called *herpes zoster*. This disease is one which affects both children and adults. I shall, therefore, not dwell especially upon it, but shall merely give you the main symptoms and the characteristic appearances of the skin, which will enable you to diagnosticate it.

**SYMPTOMS.**—The general symptoms of *herpes zoster* are fever, loss of appetite, and pain in some part of the head, trunk, or extremities. The pain is always located in the course of certain nerves. In some cases, however, the pain and constitutional symptoms are absent. In this little girl



(Case 207) it is in the nerves which supply the skin of the upper part of the back, the upper part of the axilla, and the upper part of the chest in front.

One of the characteristics of the efflorescence is that, as a rule, it is unilateral. It is extremely rare for the affection to be bilateral and to extend around the body. Cases of this kind, however, have occurred, and do not seem to be any more severe, except that larger surfaces are affected than where the affection is unilateral. The character of the efflorescence is essentially vesicular, and it is to be differentiated from varicella, which might be accompanied by the same general symptoms and is also essentially a vesicular disease. As I shall presently explain to you, the efflorescence of varicella is general, is not limited to any special distribution of the nerves, nor is it painful, while the efflorescence which we are examining here is, as you see, limited to the distribution of a special set of nerves,—in this case the brachial plexus. The vesicles become somewhat pustular, and soon crusts are formed. In this case, which has lasted three days, there are still a few vesicles to be seen, but a large part of the efflorescence is represented by crusts.

CASE 207.



Herpes zoster of right upper chest. Female, 4 years old.

The disease runs a definite course of about fourteen days, and from the beginning is accompanied by considerable pain, though according to my observations the pain is not so severe in children as in adults, nor is the itching so annoying.

Herpes zoster, so far as we can determine, is not caused by a micro-organism, but is a constitutional disease closely connected with the nerves.

The next case (Case 208, page 480), a boy, has the same disease, but it affects a different set of nerves.

In this case the efflorescence starts at the sacrum, while in the case of the little girl it started over the cervical region. Beginning at the sacrum, it follows the course of the nerves, over the left buttock and down the left leg as far as the knee. The various lesions are the same as I have just described in the previous case.

You see, then, the perfect similarity in the character of the lesions and in the distribution so far as following a particular set of nerves is concerned.

**DIAGNOSIS.**—The diagnosis of this disease is very easily made from the general symptoms of pain, fever, and malaise, in combination with the characteristic efflorescence, and we at once know with what disease we are dealing, for no other affection of the skin has so definite a distribution.

**TREATMENT.**—The treatment is simply palliative. What I am accustomed to do is to regulate carefully the child's diet, as I would in any disease with general constitutional symptoms, and to endeavor by the appli-

eration of lotions to allay the pain. The treatment which I shall adopt in this case is to powder the lesions thickly with some simple powder (Prescription 2, page 130).

CASE 208.



Herpes zoster of left leg. Male, 6 years old.

**PITYRIASIS.**—*Pityriasis* is a term that is now, like the word lichen, seldom used without an accompanying adjective. There are two recognized forms of the affection.

(1) **PITYRIASIS RUBRA** is a rare disease in children, characterized by hyperæmia and fine scales affecting, as a rule, the whole cutaneous surface. It may be attended with great constitutional disturbance and lead to death. Its duration is always uncertain.

(2) **PITYRIASIS MACULATA ET CIRCINATA**, or **PITYRIASIS ROSEA**, affects children as well as adults. It appears in the form of small patches of scales scattered over the trunk, legs, and arms. These patches either spread peripherally or unite to form larger patches while the centre undergoes involution: we thus see a reddish scaling border and a characteristic yellowish centre. There may or may not be great pruritus accompanying it. In Vienna this affection is still regarded as a form of ringworm, a position that cannot, however, be maintained. Its etiology is obscure. It gets well spontaneously in from two to ten weeks, and is best treated by mild, soothing, and antiparasitic applications.

**VERRUCÆ** (Warts).—Warts are circumscribed outgrowths of the

papillæ of the skin with an accompanying increase in the thickness of the epidermic layers. They are common in children, especially on the hands, and the old view that they are contagious and auto-inoculable has gained many adherents of late. They are of various aspects and shapes, and may be treated, as a rule, locally with success, although some are quite obstinate. The most efficacious method of treatment is painting each with a solution of salicylic acid in flexible collodion (Prescription 65).

## PRESCRIPTION 65.

<i>Metric.</i>		<i>Apothecary.</i>	
	Gramma.		
℞ Acidi salicylici . . . . .	3   75	℞ Acidi salicylici . . . . .	ʒi ;
Collodii . . . . .	30   00	Collodii . . . . .	ʒi.
M.		M.	

This is applied with a camel's-hair brush twice a day for three days. Then it is soaked off by prolonged bathing in warm water, with the addition of pumice soap if there is no inflammation. This will usually remove a portion of the wart, and the process should be repeated as long as any of the growth is left.

The treatment with salicylic acid is not always successful, and recourse may then be had to glacial acetic acid, or to some other caustic, carefully applied ; or the growth may be excised.

**LENTIGO** (Freckles).—Freckles are small aggregations of pigment deposited in the skin, and are commonly seen in children of ten years and upward, especially in those of light complexion. They are usually situated on the face and hands, but may occur on the covered portions of the body, a fact that led Hebra to regard them as not due to the action of the sun. There can be no doubt, however, that the sun is the chief agent in their production. Their removal is often difficult and requires the use of strong irritants, such as corrosive sublimate. It is rarely advisable to attempt their removal in young children.

**MELANODERMA LENTICULARIS PROGRESSIVA** (Kaposi's Disease) is a very rare disorder, and is seldom met with in this country. In this affection spots of pigment like freckles appear on the uncovered parts of the body first, finally extending more or less over the whole cutaneous surface. The pigment-spots are the first lesions seen, but later an atrophy of the skin and the formation of small angiomas dotted over the surface take place, giving the child an extraordinary appearance. The disease is usually found in more than one child in the same family, and its etiology is very obscure. Malignant tumors with a fatal ending usually result from this affection.

**LICHEN**.—Many of the affections that were formerly included under the head of lichen are now considered by most authorities to belong in other groups, notably in that of eczema. A diagnosis of lichen is never made by American dermatologists, but *lichen planus* is a well-marked skin disorder which retains a place of its own. It rarely occurs in children, but when



present it follows about the same course as in adults. It is characterized by firm papules of an irregular shape and glistening appearance, of a peculiar reddish-blue or violet color, with usually a slight depression in the centre. The individual papules may coalesce, so as to form patches of greater or less extent, covered with fine scales. It is often accompanied by great itching and discomfort. It attacks all parts of the body, showing a predilection, however, for the flexor surfaces of the arms and legs. It may last for many months, and in the most favorable cases does not disappear for several weeks. The general health is not usually affected, except by the exhaustion that may be caused by intense itching. It may be confounded with a papular syphilide, which it often closely simulates, and sometimes it may be mistaken for an eczema. Arsenic is of value in chronic cases, and antiparasitic lotions and ointments, especially those containing tar in some form, give relief as external applications.

**ICHTHYOSIS.**—The disease *ichthyosis* as it occurs in infants and young children does not differ in its general pathology from that which is seen in adults. It may occur in intra-uterine life, and is then designated *foetal ichthyosis*.

The most thorough work which has been done on the ichthyosis of infancy and childhood is that of Ballantyne of Edinburgh, who designates that form which has occurred in utero and is fully developed at birth as (1) *foetal ichthyosis*, while the form which begins in the early weeks of infancy he speaks of as (2) *ichthyosis neonatorum*.

(1) **FŒTAL ICHTHYOSIS.**—The severity of foetal ichthyosis varies greatly. The grave form, according to Ballantyne, is developed probably about the fourth month of intra-uterine life, and is characterized at the time of birth by the existence all over the body of horny epidermic plates separated from one another by fissures and furrows, associated with deformities of the mouth, nose, eyes, lips, and limbs, and leading within a few days or even hours to the death of the infant. As in most cases infants with this disease are born alive, foetal ichthyosis cannot be considered to be a cause of intra-uterine death. The disease does not seem to affect especially the size and weight of the infant. As a rule, the viscera at the post-mortem show nothing abnormal except an unusual degree of congestion. The microscopic examination shows no extension of the keratinizing process on any of the mucous membranes.

The minute anatomy of the disease has been carefully studied by Kyber and Carbone, and the most striking feature of the diseased condition is found to be an enormous thickening of the epidermal layer. This increase in the epidermis is due almost entirely to hypertrophy of the stratum corneum. The results of still further investigation seem to show that the proliferating activity of the cells, instead of being increased, is actually diminished. In a case examined by Southworth the rete Malpighii, the corium, the sweat glands, the sebaceous glands, and the hair-follicles were found to be normal.

**SYMPTOMS.**—In the early hours of life infants with this disease usually cry loudly and continuously, but sometimes the cry is feeble and often very peculiar. The respiration is usually impeded by the blocking of the nostrils with epidermic masses. Suction is rendered difficult or altogether impossible by the presence of ichthyotic plates around the mouth. They, however, are usually able to swallow readily. As a rule, nothing abnormal is found in connection with the urine or the fæces. Insomnia is a marked symptom.

These infants have a very repulsive appearance, and there is a cadaveric odor arising from the abnormal condition of the skin. This ichthyotic condition of the skin is usually universal, but is most evident upon the face. The mouth is ordinarily kept open by the contraction of the surrounding parts, and from its angles radiate fissures which simulate the rhagades of syphilis. The lips are thick and everted, so as to form an irregular entrance to the gaping buccal cavity. The chin is receding. The nose can scarcely be seen, it is covered so thickly with the epidermic plates around the nostrils. There is usually ectropium of both eyelids, but sometimes only of the upper one, the orbits seeming to be occupied by fleshy tumors. If, however, we separate the swollen eyelids, the normal eyeball is found to lie beneath. The external ear seems to have disappeared almost entirely.

In contradistinction to the opinion formerly held that foetal ichthyosis was a general seborrhœa, it is now generally supposed to be connected with the disease as it occurs in the adult.

**PROGNOSIS.**—The prognosis of the disease is almost always unfavorable.

**TREATMENT.**—The treatment should be active and directed towards softening the epidermic scales by means of warm oil inunctions.

Besides the grave form of foetal ichthyosis, there is a much milder form of the disease. It develops during intra-uterine life, and shows a continuous layer of a substance resembling collodion extending over the whole body and falling off in small flakes resembling pieces of tissue-paper. These general appearances are sometimes accompanied by ectropium and eclabium. The disease is not, as a rule, fatal, and often terminates in complete or partial cure. There have not been any instances, so far as I know, of an infant's being born dead with this form of ichthyosis.

**TREATMENT.**—The treatment of this second form should be by continual stimulation of the child's general strength and by great care of the skin.

(2) **ICHTHYOSIS NEONATORUM.**—Ichthyosis in the new-born infant, where at birth there was no sign of the disease, may occur. It presents the same appearances as the milder form of foetal ichthyosis and the ichthyosis of the older child and the adult.

This is the common form of ichthyosis, which occurs at all ages. It usually begins in the early months of life, is essentially chronic, and is very intractable to treatment.



**TREATMENT.**—It should be treated by the administration of a warm bath once daily, followed by an inunction with glycerite of starch.

**SCLERODERMA.**—*Scleroderma* is a disease which at times occurs in children as it does in adults. It consists of an induration of the skin either in bands or in patches, or is diffuse, having a board-like hardness, so that the skin cannot be raised by the fingers and feels as though it were tacked down. Scleroderma affects the motions of the joints, and when it occurs about the chest and throat may interfere with respiration. It appears to be a condensation of the fibrous layers of the skin, so that the bundles of muscular fibre are packed closely together and are increased in number. It is chronic, is not very dangerous, and is best treated by massage and lubricating applications.

**SCLEREMA NEONATORUM.**—*Sclerema neonatorum* is evidently a constitutional disease, and I have therefore already described it in my lecture on "Diseases of the New-Born" (Division VIII., Lecture XX., page 453).

**ŒDEMA NEONATORUM.**—*Œdema neonatorum* is a rare disease, which some authorities describe as distinct from sclerema neonatorum, the chief difference being that the skin pits on pressure and is not so hard as in the latter disease. The general symptoms of the two diseases resemble one another very closely.

**ACUTE CIRCUMSCRIBED ŒDEMA.**—A lesion of the skin which has been termed *acute circumscribed œdema* is represented by the sudden appearance of circumscribed swellings of certain parts of the body, varying in intensity and size in different localities. It is closely allied to urticaria, and was formerly described under the name of *giant urticaria*. We do not know much about either its cause or its pathology. I have sometimes met with it in children where it was evidently of reflex origin, depending, probably, upon irritation in various parts of the body, such as the mouth, the genitals, and the gastro-enteric tract.

It is not dangerous, may occur at any age, and its treatment is simply symptomatic.

A case illustrating this disease came under my notice not long since.

A little boy (Case 209), two and one-half years old, had had diarrhœa during the summer, and had been left in rather a weak, debilitated condition. He had for some weeks been pale, fretful, and constipated. His appetite had been capricious, and he had not cared to take any food but milk. When he was nineteen months old an egg had been given to him, which he vomited, and later a slight swelling of both eyes had occurred, lasting for a day or two.

When I saw the child the history that was given me was that in the morning he had eaten an egg. Soon after he became rather dull and cross, but did not vomit. A slight swelling of both eyes was then noticed, and later, when I saw him, the right eye was very much swollen, so that the conjunctiva was corrugated, and the tissues of the eyelids and of the cheek under the eye were so swollen that the eye itself could be examined only with the greatest difficulty. Each time that the child had eaten an egg this swelling occurred in about fifteen minutes. In the course of a few hours the swelling passed off, and did not return. An examination of the urine gave the following result:



## ANALYSIS 59.

Color . . . . .	Normal.
Reaction . . . . .	Acid.
Urophæin . . . . .	Diminished.
Indoxyl . . . . .	Increased.
Urea . . . . .	Increased.
Albumin . . . . .	Absent.
Sugar . . . . .	Absent.
Bile pigments . . . . .	Absent.
Specific gravity . . . . .	1024.
Chlorides . . . . .	Normal.
Earthy phosphates . . . . .	Normal.
Alkaline phosphates . . . . .	Slightly increased.
Sediment . . . . .	Slight increase of mucus and of epithelial cells.

Another instance (Case 210) of this kind occurred in a little boy, three years old, in whom the peripheral irritation was evidently dependent upon a tight and irritating prepuce. In this case sudden œdematous swellings of the fingers and backs of the hands would occur at irregular times, lasting for a few hours, and would then entirely disappear. These manifestations continued until the child was circumcised, since which time the symptoms have not returned. In this case, also, the urine was found to be normal.

**TUBERCULOSIS OF THE SKIN** (Lupus, Scrofuloderma).—The next case that I have to show you is one of a class the cause of which for many years was unknown. It was designated by various terms, according to the different forms which it assumed on the skin. Thus, in one form it was called lupus, in another scrofula. We now know that all these forms are caused by the same micro-organism, the *bacillus of tuberculosis*, and that this bacillus may find its nidus in the skin as it does in various other organs of the body. That is, we may have a local tuberculosis of the skin.

## CASE 211.



Tuberculosis of the skin. Female, 7 years old.

This little girl (Case 211), seven years old, shows the lesions produced by the tubercle-bacillus.

You see these lesions on the arm where they have assumed a circular form, and in the

middle part of the forearm is one with the active part of the disease on the periphery. Where the disease has destroyed the skin in the middle of the lesion you will notice the whitish color of the atrophied skin and the resulting scar. On the right side of the face, under the right eye, and around the upper and lower lips are hard masses of indurated tissue covered with small nodules, papules, pustules, and crusts. You will also notice that, following the general rule of tuberculosis of the skin, the forehead and scalp are not affected.

The child was treated at the Children's Hospital for the disease with the actual cautery. Later the tubercular process appeared in the form of nodules in the scar. This disease, under all circumstances, is very intractable to treatment, and often causes great deformity.

This affection does not differ in the child, in its appearances, its course, and its general symptoms, from the same disease as met with in the adult. I shall, therefore, not speak of it more fully. As a rule, it causes, next to syphilis, the greatest destruction of tissue of any known disease of the skin. The time of its appearance varies, but it is more common in adults than in young children.

**TREATMENT.**—The treatment is the same as is employed when the disease occurs in adults. The fundamental object to be attained is the destruction of the diseased tissue. Where there is a small isolated area which can be easily removed by the knife, this method of treatment should be employed. We must remember, however, that by this method it is almost impossible to avoid removing the sound tissue with the diseased, and that such good results as the avoiding of unsightly scars are not obtained so well by this method as by others. Therefore where the tissues are extensively diseased and areas are involved where it is desirable to avoid scarring, such as the face, a locality which is very frequently attacked by tuberculosis, the actual cautery or electro-cautery may preferably be used, and various chemical aids, of which the solid stick of nitrate of silver as recommended by the Vienna School is a good example, have been found to be very valuable.

# DIVISION X.

## SYPHILIS. ERYSIPELAS. THE EXANTHEMATA.

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### LECTURE XXII.

#### SYPHILIS.

THE specific organism which causes syphilis has not yet been discovered. The disease as it is manifested in early life appears in two forms,—(1) *acquired* and (2) *hereditary*.

The former differs in no respect from the disease as it occurs in adults, and is transmitted by direct infection, usually through one of the mucous membranes. Its treatment and general characteristics are the same as in adults, and I shall, therefore, not do more than refer to so broad a subject as acquired syphilis.

**HEREDITARY SYPHILIS.**—The hereditary form of syphilis, on the other hand, plays an important part in the diseases of the early months of life, and is an affection which in all its phases should be thoroughly understood by those who practise among children.

By inherited syphilis we mean a congenital disease which has been transmitted to the child through one of the parents or through both. It makes its appearance either in the early months of life (syphilis of the new-born) or at a later period towards puberty (retarded syphilis). The stage which is met with at birth usually corresponds to an early stage of acquired syphilis, while that which is delayed until later childhood or puberty corresponds to a later stage.

The question whether the infant can inherit syphilis from the father without the infection of the mother is one which has not yet been determined finally. The weight of evidence is in favor of the view that its occurrence in this way is not possible. The probability is that some mild and transient form of the disease has been overlooked in cases where the mother has been apparently healthy, especially as the mother of a syphilitic infant is always immune to infection by her infant. Instances, however, occur where it is impossible to say that the mother of an undoubtedly syphilitic infant is also syphilitic. A case of this kind I have here to show you to-day.



The father of this infant (Case 212) acknowledges having been treated for a primary syphilitic lesion which was followed by pronounced secondary symptoms. The mother (Case 213) is, as you see, a healthy, strong woman, who has always been perfectly willing to give any information required either as to her own or as to her husband's condition, in order to aid in the preservation of her infant's life. She states that she has never had any miscarriages, that she was perfectly well both before and after the birth of this infant, and that she has never had an efflorescence on her skin, a sore throat, or any lesions of the mucous membranes. She came under my observation when her infant was six weeks old, and has since then been seen sufficiently often for me to say that so far as I can determine she has had no symptoms that in any way could be attributed to syphilis. She has always had a plentiful supply of breast-milk, which was evidently of good quality.

The severity of the disease determines the type of the efflorescence, and is also influenced by the time when the infection of the foetus took place. Thus, the later the period of infection the milder will be the form of the efflorescence which first appears, while the less severe the general symptoms the better will be the prognosis and the greater the amenity of the disease to treatment. The reverse of these rules is found where the infection has taken place early, and where, as a result, the infant is born dead, or at birth shows such advanced stages of the disease as are represented by the more intractable forms of efflorescence and severe general symptoms, making the prognosis exceedingly grave.

It is probably possible for a syphilitic foetus to infect its mother in utero. This theory of *retro-infection*, however, has not been universally accepted. Fournier believes that there is a class of cases in which the father at the time of marriage has no lesion which would necessarily infect the mother, where the mother never shows any initial lesion and remains free from syphilis so long as she is unimpregnated, and where after impregnation she becomes syphilitic and either aborts or gives birth to a syphilitic infant. In connection with the subject of retro-infection the question arises whether a mother who becomes syphilitic during her pregnancy can infect the foetus (*post-conceptional syphilis*). There is no doubt that she may abort from her own syphilitic infection, but it has not yet been clearly proved that the foetus in these cases is also syphilitic.

It has been found that where a woman is syphilitic it is exceedingly common for her to abort. Miscarriage is more frequent when a woman is passing through the early stages of syphilis than later when she has become more or less habituated to the disease. The treatment by mercury in these cases soon after impregnation, and continued during the pregnancy, is a valuable means of averting abortion. You must remember that although the aborted foetus of a syphilitic woman is usually macerated, yet such a condition of the foetus may be produced by other diseases as well as by syphilis. Birch-Hirschfeld has found from an examination of a large number of macerated foetuses that seventy per cent. were undoubtedly syphilitic.

Although the tendency to transmit the disease is greatly lessened by time, yet the thorough treatment of the parents by mercury is the most

powerful means of preventing such transmission, and the careful use of this drug in proper doses is never contra-indicated. It is, therefore, evident that when a syphilitic woman becomes pregnant she should be treated with mercury whether she was infected before or after conception. When both parents are syphilitic, and when their syphilis is in the early stages, the infant is most likely to inherit the disease, and under like conditions the disease is apt to be of a severe type.

Infants entirely free from syphilis, either at birth or later, have been known to be born of parents of whom one or both were undoubtedly syphilitic. Through the courtesy of my colleagues at the Boston Dispensary, Dr. Dixwell and Dr. Greenough, I am enabled to show you some cases of immunity in children born of syphilitic parents.

These children (Cases 214 and 215) are two of a family of five, all of whom were healthy at birth and none of whom have ever shown any symptoms of syphilis. The father was infected with syphilis before marriage, and later infected his wife. They were both carefully treated with mercury. The wife has never had any abortions. She has had five children and has lost none. Both father and mother have had undoubted secondary and tertiary lesions, some of which still exist.

The father of this next child (Case 216) is a rag-sorter, who had a primary syphilitic lesion on his hand twelve years ago. This lesion was followed by secondary symptoms. He never had any lesion on the penis. While he was being treated his wife showed symptoms of syphilis and was also treated with mercury. This child has always been healthy, and is one of three, none of whom have ever developed any syphilitic lesions.

**PATHOLOGY.**—The pathological tissue-changes which take place in the hereditary form of syphilis are of the same nature as those which occur in the acquired form. Diffuse *interstitial hyperplasia* is much more common in the hereditary form than are circumscribed gummy tumors. Changes in the bones are very common in hereditary syphilis, and in fact so much so that it is usually considered necessary to find these osseous changes in order to establish a diagnosis of syphilis in the foetus.

**Liver.**—Gubler's description of the alterations which take place in the livers of syphilitic infants is as graphic and as reliable as any which have been since given. The liver is always larger than in the normal condition. He states that the hepatic tissue is harder and more elastic than usual, that it is of a yellow color, and that there are small white granulations scattered throughout the parenchyma. The hepatic acini under normal conditions are in contact, except at the prismatic spaces formed by their union, in which spaces the capsule of Glisson forms an envelope to the afferent portal vessels of the lobule. It is in these spaces that the round lymph-cells form and collect into small lobules representing microscopic gummata. The gummata of the liver which are found in young children with hereditary syphilis resemble those which occur in adults.

**Spleen.**—Parrot states that next to the osseous system the spleen is the part most often affected by syphilis. It is enlarged, and the degree of splenic enlargement is usually characteristic of the severity of the disease.



**Pancreas.**—Birch-Hirschfeld has pointed out the fact that the pancreas is frequently found to be affected in hereditary syphilis. He remarks that the interstitial changes which he found in the pancreas are analogous to those which occur in other organs, especially the liver, and that, while these changes are not constant, they come next in frequency to the alterations in the spleen. The interference with the function of the pancreas, which must occur where it is diseased to any great extent, is probably the cause of the gastro-enteric disturbances so common in hereditary syphilis.

**Throat, Upper Air-Passages, Thymus Gland, and Heart.**—Extensive lesions are at times found in connection with the pharynx, larynx, trachea, and neighboring parts, and also with the thymus gland and with the muscles of the heart.

**Lungs.**—In cases of hereditary syphilis born before term, and in those born at term who live but a few days, the lungs present certain pathological conditions represented by nodules or small tumors, usually superficial and varying in size. Sometimes an entire lobe may be involved, and the dense, altered lung-tissue is colorless gray or white, both on its surface and on its section. This condition has been called by Virchow *pneumonia alba*, white hepatization.

**Kidney and Testicle.**—The kidney and testicle may show the lesions of syphilis. It is to be noted that the lesions of these organs are amenable to treatment. The disease in the testicle is represented by a gradual enlargement, and is usually bilateral.

**Osseous System.**—The changes in the bones which take place in hereditary syphilis are so important, not only on account of their pathological interest, but also because of their clinical significance, that especial attention should be paid to them.

In this connection it should be remembered that in the latter part of intra-uterine life the long bones are cartilaginous and the process of ossification is intra-cartilaginous. As the cartilage changes to bone the cartilage-cells increase in number and are closely crowded together. Then comes the area of osteoblasts, then the calcareous matter, and deeper down in the ossified portions are the blood-vessels running in from the periosteum. The epiphyses of the bones of the arm are cartilaginous at birth, and they remain separated from the shaft of the bone for some time by a narrow cartilaginous layer. It is in this cartilaginous separating layer, called the zone of proliferation, represented in this drawing of a normal infant's bone (page 1066, Fig. 148), that certain changes are found in hereditary syphilis. This same cartilaginous layer is a marked feature in the changes which take place in the bones of cretins and of rachitic persons. These I shall describe later, but, as you see, they are represented in this illustration. It is also at this zone of proliferation that the growth in the length of the bone takes place, and here syphilitic changes are most often found. This lesion is an osteochondritis, and may occur together with lesions of the spleen and other parts of the body, or as the only manifestation of the disease.



Osteochondritis is ordinarily the form of bone-disease in infants. Osteoperiostitis belongs almost exclusively to the later forms of hereditary syphilis as they appear in well-grown children and in young adults.

The bones which are affected most commonly are those of the arms and of the legs.

Besides these common osseous lesions a morbid condition of the fingers and toes, called *dactylitis*, occurs quite frequently. In this condition the fingers and toes assume a peculiar pyriform shape.

In addition to these purely syphilitic changes, local thinning of the bones of the skull, called *craniotabes*, occasionally occurs. In this condition the bone-substance is absorbed, leaving only the integuments and membranes.

SYMPTOMS.—In the mild form of the disease the infant may be born apparently healthy and may show no indications of its syphilitic inheritance for some weeks. It is rare, however, for the symptoms to be delayed beyond the first three or four months of life. The earliest symptoms of hereditary syphilis correspond to the secondary symptoms of acquired syphilis. Commonly, unless the infant is born with the efflorescence, it is noticed at birth, or within two or three weeks, to have occlusion of the nares (snuffles), and, soon after, a hoarse cry and an efflorescence of a macular or a papular variety. The efflorescence is general, includes the palms of the hands and the soles of the feet, and is especially prominent on the forehead.

The condition of the infant depends considerably on that of the mother. The rule is that these infants when born are emaciated, presenting somewhat the appearance of these premature infants (Cases 102 and 106, pages 291 and 303), but I have seen them well developed and apparently in good condition, as is shown by this infant (Case 218, page 501), which I shall presently allow you to examine. The disease, with appropriate treatment and good feeding, may in some cases be arrested in this stage, and be cured so that it will not return, or it may advance to another group of symptoms, which are represented by lesions of the mucous membranes. These lesions consist of fissures at the angles of the mouth, mucous patches in the mouth, and condylomata of the anus. In addition to these manifestations, pseudo-paralysis of one or both limbs of a greater or less degree may occur. All these symptoms may arise, run their course, and completely disappear, sometimes never to return. Again, they may reappear at various times during the individual's life, but they are especially liable to return during the middle period of childhood and at puberty.

THE EARLY MANIFESTATIONS OF HEREDITARY SYPHILIS.—I have already explained to you that we can judge to a great degree as to the severity of the disease by the type of the efflorescence, and also by the time when it occurs after birth. The mildest and most benign form of syphilitic efflorescence is represented by *maculæ*, the next by *papulæ*, and the next by *pustulæ* and *bullæ*. Another form of efflorescence simulating *psoriasis* is one of the more severe manifestations of syphilis, as is also that form which

is called *rupia*, where the efflorescence consists of thick layers of crusts arranged one above the other, forming a conical mass, the skin at the base being somewhat infiltrated. All of these types of the disease have been known to be cured. Finally, you will at times meet with a very dangerous form of the disease, which is almost uniformly fatal no matter what the treatment may be. This is what is called *syphilitic pemphigus*, and is represented by large and numerous bullæ.

These syphilitic efflorescences, unlike most other lesions of the skin, appear commonly on the palms of the hands and the soles of the feet.

Here is an infant which I showed you at a previous lecture (Lecture XV., Case 127, page 367) to illustrate the enlarged spleen which is found commonly in cases of secondary anæmia produced by hereditary syphilis. As seen to-day it well illustrates what I have just said concerning the syphilitic efflorescence appearing on the soles of the feet.

#### CASE 127.



Syphilitic maculæ, ulcers, and bullæ on the soles of the feet. Male, 2½ months old.

It is a male, two and one-half months old. About one month previous to its birth its mother had an efflorescence limited to the head: her hair fell out, and she had a sore throat. The infant was apparently healthy at birth and during the first six weeks of its life, and had no unnatural appearances on its skin. It was then noticed to have an efflorescence of an erythematous type on the body, face, and arms, including the palms of the hands and the soles of the feet. This efflorescence was in the form of maculæ of a bluish-red color. On examining to-day the soles of the feet, we find, in place of the pronounced maculæ which you have previously seen, pigmented areas. You will also notice on the under side of the toes at their junction with the metatarsal bones a number of bullæ, some of which have burst, and, the tissue beneath having broken down, ulcerations have been formed. In other parts of the soles you will also notice ulcers of various sizes, a few papules, some smaller bullæ, and the pigmented areas already referred to.

There is marked occlusion of the nares, and an examination of the nose which has been made by Dr. Coolidge shows that the turbinated bones on the left side are swollen and that there is some infiltration of the mucous membrane of the naso-pharynx. There is also a sero-purulent discharge from the left eye.

In a case of this kind, provided that we can eliminate the extreme lesions of scabies, there can be no doubt that the lesions are those of syphilis.



In addition to these general symptoms which I have just described, there occurs in the hereditary form of syphilis the loss of hair which, as you know, is so common in the acquired form of the disease. This *alopecia* may be caused by any of the dermal lesions which occur during the course of the disease, but is probably due mostly to the general lack of nutrition in which the skin participates with the other organs of the body in syphilis. In certain cases the eyebrows and eyelashes are lost, and Barlow believes that the former condition is characteristic of the disease, or at least should excite a suspicion of its presence.

Enlargement of the lymph-glands, *adenopathy*, seems to be less marked in hereditary syphilis than in the acquired form. This enlargement may be due to reflex irritation from the more severe dermal lesions, but in certain cases it is found where no dermal lesion exists. The enlarged glands may be in the inguinal, the axillary, or the cervico-maxillary regions. They are distinct, movable, multiple, and non-inflammatory. The older the child the more likely the glands are to be enlarged.

According to Post, the nails are involved quite frequently in hereditary syphilis, and more frequently than in the syphilis of the adult. The *onychchia* occurs in two forms. In the first form a papule or pustule appears on the skin at the side of the nail. This ulcerates and extends along the side of the nail, at times involving the matrix and causing the loss of the nail. The thick and everted edges of the ulcer, its sloughing base and sanious discharge, are somewhat characteristic, and are accompanied by a painful enlargement of the distal phalanx. (For second form of *onychchia* see page 506.)

The effect of hereditary syphilis on *dentition* is quite marked. The first teeth instead of being cut in the sixth or seventh month may not appear until the fourteenth or fifteenth month, and sometimes even later. These primary teeth are especially liable to decay early. There is nothing sufficiently characteristic to be of diagnostic value in the appearance of the teeth of the first dentition.

Mr. Hutchinson has observed twenty-three cases of *iritis* in syphilitic infants. The average age for the beginning of the *iritis* was five and a half months. The oldest was sixteen months at the time of the outbreak, the youngest six months. Both eyes were affected in eleven cases, and in fifteen cases the effusion of lymph was copious. The cornea was affected in a few cases. In seven cases the cure was complete, in twelve the pupil was partially occluded. *Iritis* is one of the rarest of the symptoms of hereditary syphilis, and at times escapes notice on account of the very slight symptoms which usually attend it. The diagnosis in these cases is not dependent on the *iritis* alone, but the infants always show other well-marked symptoms of syphilis. There is great danger of the disease resulting in blindness if it is left untreated, and mercurial treatment is most efficient in effecting a cure.

In regard to the *digestive disturbances* which arise in these cases of hereditary syphilis, it is well to remember that they may depend upon a



syphilitic lesion of the liver, spleen, and pancreas, as well as of the stomach and intestines. It is, therefore, necessary to treat these disturbances of the gastro-enteric tract in a different manner from what is customary where a local non-syphilitic cause is supposed to be present. In fact, mercurial treatment will produce the best results in these cases.

An affection called *syphilis hæmorrhagica neonatorum* is met with at times. Bunstead and Taylor have reported two cases of this kind, and state that the disease is rare, less than twenty cases having been noted. The hemorrhages vary in their extent, and may occur in either the skin or the mucous membranes. This class of cases is difficult to differentiate from the hemorrhagic disease of the new-born which I have already described. There is no doubt that syphilis has in a number of cases an etiological significance in the umbilical hemorrhage which occurs in the early days of life. Dr. Uracek has reported a series of hemorrhages in the different internal organs apparently depending upon a syphilitic taint in the infant.

The course of syphilis is so influenced by treatment that the symptoms must necessarily be irregular. When the disease is untreated, as a rule, all the symptoms grow worse. The infant becomes more and more emaciated, and either it dies in a few weeks of inanition, or the disease progresses still further and serious lesions of the various organs, such as the lung, liver, spleen, and kidney, may finally produce a fatal result. The *occlusion of the nares* may increase to such a degree that the breathing of the infant is seriously interfered with, and, without any other syphilitic lesion, it may die from imperfect oxygenation of the air which enters its lungs.

This occlusion of the nares may cause great loss of sleep. We must, however, understand that, even where this lesion is not of any great extent, syphilitic infants suffer from *insomnia*. This insomnia is usually accompanied by crying, so that it is probable that the restlessness and insomnia are due to pain in the bones, as these symptoms are often present where there is no digestive disturbance.

In connection with these syphilitic lesions of the nose, flattening of the bridge of the nose is at times a noticeable symptom.

There is nothing especial to describe concerning the *condylomata* which are found in the *anal region* and are rare in comparison with the lesions of the mouth. They begin as rounded papules, which sometimes coalesce, and there is more or less infiltration of their edges and breaking down of their centres.

The syphilitic lesions of the *mouth* are found so commonly, and are of so important a character, that an especial description should be given of them. There is no syphilitic lesion of the mouth which is represented by a characteristic stomatitis. The mucous membrane in the course of hereditary syphilis may at any time be in so sensitive a condition that the various forms of stomatitis may be engrafted on it, and we thus may have different lesions of the lips, tongue, buccal cavity, and tonsils, which, while

simply representing the lesions of certain non-syphilitic affections, may, by their peculiar grouping in combination with other symptoms, represent the hereditary form of syphilis. The lesions most commonly appear around the lips and on the mucous membrane lining the cheeks. On the lips fissures are exceedingly frequent; on the upper lip they commonly appear on either side of the median lobule, while on the lower lip they are usually single and in the median line. The angle of the mouth is often the seat of condylomata, and these are frequently covered with crusts and at times are deeply ulcerated. A peculiar appearance is in some cases seen at the commissures of the mouth, caused by cutaneous ulcerations, which make it look larger than normal, and at times produce a number of lines radiating from the mouth to the cheeks. Ulcerations may occur on the tongue, the lips, and the fauces. Forchheimer has written more fully on these lesions of the mouth than any other author, and his observations, now so widely known, leave little additional to be said on the subject. His description of the fissures which occur in syphilitic infants' mouths is very minute. He considers that when they are present they leave no doubt as to the diagnosis, since they are infiltrated. The most common place for them to appear is at the corner of the mouth. In this place, as a rule, the most striking feature of the fissure is that it is a papule which has been split in or about its middle, and that it has an infiltrated edge. The fissures sometimes disappear in the mucous membrane, sometimes stop before reaching it, and sometimes run into it. The fissures may or may not be covered by a crust, and, unlike most syphilitic efflorescences, produce more or less pain when the mouth is opened. These fissures are called *rhagades*. They are characterized by their persistency and by their lack of tendency to spontaneous healing. Ulcers and *plaques muqueuses* may be found upon the mucous membrane of the lips and cheeks and on the sides and under surface of the tongue. They are superficial, but cover more space than the fissures. The infiltration is not so well marked, but is present to a greater or less degree. The most common lesions which are found on the tongue are these plaques muqueuses and ulcers. Both have infiltrated edges, but the plaque in this situation rises above the level of the tongue, while the ulcerations are considerably depressed. They are both characteristic of syphilis. Their locality is determined somewhat by the presence of such irritants as sharp teeth pressing against a portion of the tongue.

The secretion of all these lesions of the mouth and lips is highly infectious.

One of the striking symptoms of this early stage of hereditary syphilis results from osteochondritis. According to Post, the form of lesion is usually that of a tumor at the junction of the diaphysis and epiphysis at the distal end of the long bones, though any part of the osseous system may be involved. These swellings are difficult to recognize in fat children. The tumors rise abruptly from the bones; they are small and globular, and in some cases form a ring at the junction of the shaft and epiphysis; in others



the whole epiphysis is enlarged. At times only a part of the cartilage is affected, and the external swelling is correspondingly circumscribed. The lesions appear soon after birth, and their development is completed either slowly or rapidly. The termination varies widely. The swelling may be absorbed under appropriate treatment, or suppuration may take place and the skin break down; the disease may end in the separation and destruction of the epiphysis. The result upon the final growth of the bone varies, of course, with the severity of the local disease. When the morbid process is arrested before the destruction of either cartilage or epiphysis, there is no deformity, but the destruction of cartilage puts an end to growth at that point, and a more or less shortened and useless limb results. When the disease takes such a course as to separate the epiphysis while the integuments remain sound, the limb becomes useless for a time and appears to be paralyzed. The disease was first fully described by Parrot, and is known as Parrot's disease, or *syphilitic pseudo-paralysis of the new-born*. The joints in immediate connection with the diseased bones are sometimes involved. There may be simply an effusion, but, where the bone is destroyed, serious disorganization of the joint must follow. The pain and sensitiveness in these cases of pseudo-paralysis are probably caused by a low grade of periostitis.

The bones of the fingers and of the toes, I have already told you, present at times the peculiar lesion which is known as *dactylitis syphilitica*. The phalanx may be enlarged to two or three times its natural size, giving the fingers a pyriform shape. One or several fingers or toes may be involved, and sometimes the metacarpal bones are diseased. The proximal phalanx is more frequently affected than the distal phalanx. In the early stages the integument is unchanged; later, the overlying parts become involved and abscesses form. If the case is submitted to early treatment the deformity usually subsides, but if untreated the disease may result in permanent deformity and uselessness. Dactylitis, however, is not characteristic of syphilis alone, as it occurs also as a result of tubercular disease of the bone.

Craniotabes is one of the more uncommon symptoms of hereditary syphilis, but, as I have already told you, may in rare cases be found. These softened spots, nearly circular in form and about 1.2 cm. ( $\frac{1}{2}$  inch), more or less, in diameter, may be recognized by the finger during life. Until lately craniotabes was considered to be exclusively a symptom of rachitis. It is found especially in the occiput. It is present in rachitis where no trace of syphilis can be discovered, but it seems to be most common in cases where there is a distinct syphilitic taint. Of one hundred cases of craniotabes collected by Drs. Barlow and Lees, in forty-seven there was satisfactory proof of syphilis.

DIAGNOSIS.—The diagnosis of hereditary syphilis in its more advanced forms, such as I have just described, is not difficult, as no other disease represents such serious lesions of the skin with such a combination of general symptoms and lesions of the mucous membranes.



The milder forms of the disease are frequently mistaken for other diseases of the skin which simulate the syphilitic lesions but which are of a benign character. I have already spoken of these lesions when describing such local diseases of the skin as papular erythema, and shall refer to them again when speaking of the mild forms of syphilis.

Occlusion of the nares caused by swelling of the Schneiderian membrane, if persisting during the early weeks and months of life without rise of temperature, should always make us suspicious of the presence of hereditary syphilis, for a syphilitic efflorescence is often so slight and evanescent as to be frequently overlooked.

Marked improvement from the administration of mercury is also usually considered of diagnostic value, and, although not by any means conclusive, is at least significant.

Periostitis, especially of the lower end of the humerus or the anterior border of the tibia, is met with in children. It should make us suspicious that syphilis is causing this condition, especially if there is periostitis of a number of bones at once.

A great deal has been written and much discussion has taken place regarding the relationship between syphilis and rhachitis. The two diseases are so distinctly separated that it seems scarcely necessary to dwell, except very briefly, on the differential diagnosis between them.

Rhachitis is so largely dependent in its osseous changes on a profound disturbance of nutrition that it can fairly be said to result from any disease which from its debilitating nature may interfere with the nutrition of the bones. In this way individuals whose nutrition has been seriously affected by hereditary syphilis may develop rhachitis. This, in my experience, has been a rare occurrence.

In regard to the actual lesions of the bones present in syphilis and rhachitis, there seems to be a concurrence of opinion that the pathological conditions are quite different. Thus, according to Cazin and Iseovesco, syphilitic bones very rarely present the spongy tissue peculiar to rhachitis, and rhachitic bones never show the osteophytes of syphilis.

PROGNOSIS.—From what I have already told you, the prognosis in any case of hereditary syphilis is a serious one. In addition to the results which we are likely to have from the syphilis of the parents being early or late in regard to the impregnation, and from their having been thoroughly treated or not, there are certain facts to be remembered concerning the infant itself.

The prognosis is grave inversely to the number of weeks after birth when the disease first shows itself. The milder forms of the efflorescence justify us in giving a better prognosis than the more severe ones. In addition to these conditions which render the prognosis more favorable are the possibility of the infant being fed with good breast-milk or with a carefully prepared substitute food, and good hygienic surroundings.

The cases in which the spleen is much enlarged are evidently so pro-

foundly affected by the secondary anæmia by which the enlargement is caused that the prognosis is almost invariably bad, and the degree of splenic enlargement may almost be taken as an index of the severity of the disease.

The opinion which we give to the parents should, however, always be very guarded, as, even though the disease may for the time apparently be entirely cured, it is always liable, as I have already stated, to appear again in later childhood and at puberty. When the disease is amenable to treatment these secondary symptoms almost always disappear by the second year, and in quite a large number of cases, where proper treatment has been thoroughly carried out, the infant recovers entirely and is as well and strong as though it had never had syphilis. In another set of cases, however, although the disease is apparently eradicated, in later years it is found to have left its marks in disturbances of the different functions and in the general lack of vigor of the various tissues.

**TREATMENT.**—The treatment of hereditary syphilis is first to adapt at once as nourishing a food as is possible to the infant's digestion. A healthy mother with plenty of good breast-milk will, as a rule, provide the best food for her infant.

If the mother's nutrition is reduced by syphilis or by any other chronic disease, the infant should be fed on a properly adjusted substitute food, while the general hygiene, such as fresh air, sunlight, and warmth, should be carefully regulated. A wet-nurse should not be employed unless she has herself had syphilis, in which case the same rules will apply to her nursing as to that of the syphilitic mother. A syphilitic infant does not infect its mother (Colles's law). It readily infects a woman who either has never had syphilis or who has never given birth to a syphilitic infant.

It should be remembered that the secretions from a syphilitic infant's mouth are very infectious, whether the disease is of the hereditary or of the acquired form. If, therefore, the mother is not syphilitic and the infant has acquired in any way a syphilitic lesion, the nursing must be discontinued and the infant fed on a substitute food.

The only drug which can be depended upon in the treatment of the early lesions of hereditary syphilis is mercury. This drug naturally would be employed from our experience with it in acquired syphilis, where, as you know, it is more valuable in the early stage of the disease than at any other period. In like manner iodide of potash is of little use in the early stages of hereditary syphilis, while it becomes useful in the retarded form, which corresponds to the later stage of acquired syphilis.

It is important carefully to adapt the form of mercury which you give to the syphilitic infant according to its special idiosyncrasy for the drug, and also to regulate the means of its administration according to the necessity of having it act quickly, as is indicated in the more severe forms of the disease, and according to the sensitiveness of the individual's stomach or skin. Thus, mercury may be administered either through the mouth or through the



skin. In the latter case it may be applied directly in the form of liquid or ointment or by means of subcutaneous injections. The last method should be used in very urgent cases only, for the tissues and skin of the syphilitic infant are especially liable to be irritated to such an extent that sloughing may take place, and the tissues under these circumstances are readily destroyed. When used, it should be in the form of corrosive sublimate.

The corrosive sublimate should never be given subcutaneously in larger doses than 0.0006 gramme ( $\frac{1}{1000}$  grain). Where the mercury is to be applied directly to the skin it may be in the form of corrosive sublimate baths, 0.3 to 0.6 gramme (5 to 10 grains) to each bath once daily, but practically it is found better to introduce it into the system by means of an ointment. This ointment may be the official mercurial ointment, either in full strength or diluted with some simple ointment, and this is very often applied by means of inunction, as is the custom in the acquired syphilis of adults. After the infant's skin has been thoroughly washed, a small portion of the ointment should be applied to its back and rubbed carefully and gently into the skin for ten minutes. On the next day the same procedure can be carried out on the front of the chest; on the third day in the axillary regions; and on the following days respectively on the outer surfaces of the arms and thighs. I have found that the most practical way of applying inunctions to these infants is, after having thoroughly washed the abdomen, to spread the ointment thickly on a piece of thin soft flannel cut so as to reach from the ensiform cartilage to the pubes and to extend around the entire abdomen. This ointment is made in the following way (Prescription 66):

PRESCRIPTION 66.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Unguenti oleati hydrargyri, Unguenti lanolini . . . . . āā M.	60   00	R Unguenti oleati hydrargyri, Unguenti lanolini . . . . . āā ʒii. M.

The band should be allowed to remain in place for forty-eight hours. It should then be removed, and, after the skin has been thoroughly washed with warm water and soap and dried with a soft towel, the flannel should again be spread with the ointment and reapplied.

In giving mercury by the mouth I am in the habit of using the official hydrargyrum cum creta. I usually begin with 0.06 gramme (1 grain) of the drug, administered three times in the twenty-four hours. Within a few days I increase the dose to four times in the twenty-four hours, and if no unfavorable symptoms appear I again raise the dose to 0.12 gramme (2 grains) three or four times in the twenty-four hours.

The unfavorable symptoms which I have just referred to as possibly being caused by the drug are represented by diarrhœa. We must remember that the infants whom we are treating for hereditary syphilis are so young that the salivary secretion has been very slightly developed, and that there-



fore we naturally do not salivate an infant of this age so readily as we would a child or an adult. We must not, however, think that we can be guided as to the amount of mercury we are introducing into the infant's stomach by salivation, which is usually relied upon to indicate the physiological action of mercury. I have found it a safe rule to continue with the mercury until diarrhoea is caused, when the drug can be reduced in quantity, or even be omitted for a few days. When the intestine has become less sensitive we can again begin with a smaller dose, and one which by experiment has been shown not to cause diarrhoea in the especial infant.

Other forms of mercury, such as calomel in doses of 0.006 gramme ( $\frac{1}{10}$  grain) three or four times daily, may be given by the mouth in these cases.

These various forms of mercury should be tried where for any reason one of them is found not to suit the case.

For the treatment of the fissures which occur around the lips and the lesions of the mouth, as well as those which occur at the anal orifice, I am in the habit of using a simple powder of calomel, which is dusted on the part affected. The mouth should be carefully cleansed several times during the day and a wash of chlorate of potash used at least twice a day. In some cases, though rarely, nitrate of silver is needed as an application to the ulcers when they are intractable. Where there are crusts around the lips and in the neighborhood of the fissures, or where anal condylomata are present, the ointment (Prescription 66) which I have just shown you is of much benefit. The crusts should be carefully removed from the nose and this same ointment gently applied to the lesions. The application of this ointment to the abdomen is at times followed by an eczematous irritation of the skin of the abdomen, as has happened in this case (Case 127, page 367). Under these circumstances any simple ointment should be applied in place of the mercurial for a few days until the skin has recovered, and the ointment can then be further diluted with lanoline or some simple ointment and reapplied, thus finally adjusting the strength of the mercurial to the vulnerability of the infant's skin.

In addition to the mercurial treatment, tonics in some form, especially iron, are at times required. It is usually in the later stages of the disease that they are indicated, and in cases where the persistence of the splenic enlargement shows the presence of profound secondary anæmia.

After all the symptoms of syphilis have disappeared and the infant is entirely well, the mercurial treatment should be continued for some months, and also later during the first three or four years of its life, at intervals of three or four months, even where there is no return of the syphilitic symptoms. It should likewise be given at intervals during the period of the second dentition, and again at puberty. This treatment is especially important whether the infant appears to be in good health or not, as it tends to prevent a recurrence of the disease, and you should understand that a recurrence often proves very intractable to treatment.

I have some infants here to-day who illustrate the different phases of early hereditary syphilis and the different conditions which you are liable to meet with in this disease.

This first infant (Case 217) is three weeks old. Its mother looks well and strong, denies having had any miscarriages or disease of any kind, and asserts that the father is also healthy. Both of these statements are probably untrue, as you will presently see; but we have an excellent opportunity for making a diagnosis simply by inspection and by a physical examination.

At birth the infant was puny and atrophic. It soon began to have occlusion of the nares. When one week old, an efflorescence of papules appeared on its arms, legs, and feet, with pustules on the palms of the hands and the soles of the feet. It does not vomit. The faecal movements, as you see on the napkins (Plate III., 4, facing page 112), are of a good color and fairly well digested. The heart and lungs are normal. The splenic area of dullness is slightly increased, but the spleen cannot be felt. You see that there are marked fissures at the angles of the mouth, a muco-purulent discharge from the nose, and crusts forming on the eyebrows. The mouth and throat show nothing beyond a pronounced erythema. There are papules and pustules on the body, and a squamous as well as a pustular efflorescence on the palms of the hands and the soles of the feet. There are maculae on the buttocks. The anus shows nothing abnormal. The temperature is normal. The infant looks fairly well nourished.

There can be no question about the diagnosis in a case like this, and the statements of the mother regarding herself and her husband can be entirely ignored, for by simple inspection we see at once that we have a case of hereditary syphilis to deal with.

Before referring to the treatment of this case, I shall ask you to examine another infant.

#### CASE 218.



Hereditary syphilis. Male, 6 months old. Fed on good breast-milk by a healthy mother.

This infant (Case 218) is six months old. The mother, a healthy-looking woman with plenty of breast-milk, nurses the infant. She has had one miscarriage, in the third month, and this is her first child. The father denies having had any venereal disease.



At birth the infant was rather atrophied and had a general papular efflorescence all over it, and later a squamous efflorescence on the palms of the hands and the soles of the feet. It always had marked occlusion of the nares (snuffles).

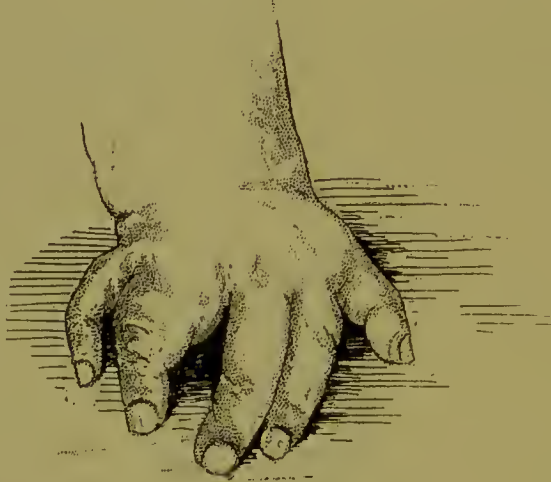
The infant was immediately placed under treatment, and now looks well nourished.

It is also a case of hereditary syphilis, and shows the beneficial result of good breast-milk and mercury, for you see that it is very large for its age and is fat and strong-looking. It has, however, certain lesions of the bones which are the result of the syphilitic manifestations which it presented at birth. One of these lesions is represented in the marked prominences which you see on either side of the frontal bone, with a somewhat depressed sulcus between them.

On examining the infant's hands you will notice a still more characteristic lesion of the bone. You see that the first phalanx of the left little finger and that of the left third finger are swollen and somewhat reddened, and that the tissues have a tendency to break down. This condition is called *syphilitic dactylitis*. It is not, however, characteristic of syphilis alone, for cases of tuberculosis of the bone often simulate this condition, and in fact so nearly approach it in appearance that the two diseases cannot be distinguished by simple inspection.

To show you the close resemblance between syphilitic dactylitis and tubercular dactylitis, I have here an infant (Case 219) on whose hand the same general characteristics will be found. In this case the third finger of the left hand is affected.

#### CASE 219.



Tubercular dactylitis.

In connection with the first of these cases (Case 217) I have stated that while the syphilitic infant is described essentially as atrophic, this is, as a rule, the case only when it is deprived of good breast-milk or of a properly proportioned substitute food, the atrophy being usually a fault in diet, provided that the intra-uterine nutrition has been good. You see that neither of these cases is suffering from malnutrition. They are being nursed by strong mothers, who are giving them a plentiful supply of milk. The second case (Case 218) is rapidly recovering, and will soon need only to be seen and treated at intervals. In fact, it illustrates remarkably well how healthy an infant may look who is but just recovering from the more severe symptoms of infantile syphilis. In the first case (Case 217) the prognosis is not quite so good, as, although the infant has been under treatment for two weeks, the lesions are marked and numerous. What inclines me, however, to look upon the case favorably is the improvement which has occurred in the mother's milk, and which will naturally find its counterpart in the infant's nutrition. The insomnia and restlessness which were present in this case have also greatly lessened, showing that the infant is improving.

An interesting and important point to be noticed in this case was that when the mother first noticed the efflorescence and brought the child to me she was so much frightened that her milk had considerably lessened in quantity, and she was sure that she would lose her



milk entirely and that her infant would die. Judging that the milk was affected by the mental condition of the mother, I at once caused a marked revulsion in this condition by stating decidedly that her milk would soon become plentiful, and that in the mean time she could give her infant in addition to her milk about an ounce of the following mixture (Prescription 67):

PRESCRIPTION 67.

Fat . . . . .	2.00
Sugar . . . . .	6.00
Proteids . . . . .	1.00

This substitute food suited the infant's digestion so well that the mother soon ceased to believe that it would die, and the desired mental revulsion was so effective that in twenty-four hours the infant was receiving its natural supply of breast-milk and the substitute food was omitted.

Syphilis is so prolific a source of miscarriage that a history of miscarriage in the mother justifies us in looking with suspicion on a doubtful lesion of the skin in her infant. A woman may have a number of miscarriages caused by syphilis, and may then, if she has been treated with mercury, give birth to a living syphilitic infant, or to one that is healthy. These facts are important for us to remember when we are considering the prognosis in a case of hereditary syphilis. For instance, the mothers of both of these infants deny having had any disease, and the mother of the first case (Case 217) says she has had no miscarriages, while the mother of the second case (Case 218) acknowledges that she has had a miscarriage. We may take it for granted from the healthy appearance of these mothers that they have been treated. This opinion, of course, is merely provisional, and does not deal with the additional argument which might be brought up, that both infants were infected by the fathers through healthy mothers. These two infants have both had the same treatment, and that treatment has been essentially good food and mercury in the form of oleate of mercury ointment diluted one-half with rose-water ointment and applied on a flannel to the abdomen. In addition to this external treatment, hydrargyrum cum creta in doses varying from 0.12 to 0.24 gramme (2 to 4 grains) three or four times a day has been given.

The next infant that I shall show you illustrates the trouble that may arise from the physician in general practice not thoroughly understanding the varied forms in which syphilis may manifest itself in infancy.

This infant (Case 220), a male, four months old, was brought to my clinic three weeks ago with syphilis of a rather aggravated type, and among other lesions this condyloma, the remains of which you now see at the anal orifice.

It had a general papular efflorescence on the face, body, and limbs, including the palms of the hands and the soles of the feet. The left arm hung helpless by its side. You see that it can now move it a little. The left leg was also somewhat affected. On examining the arm I found that there was a small, hard, painful, circumscribed swelling at the lower end of the humerus. No crepitation was detected. The infant was treated with mercury, and a carefully proportioned substitute food was given to it. The mother was cautioned to be very gentle when she moved the arm, and to come frequently to the clinic for observation.

She did not bring the infant again for two weeks, but when she did she was very indig-

nant, because she thought her infant had not been properly treated at the previous visit. She said that she had been to a surgeon, who had told her that the infant had a broken arm, and that the hard swelling was the resulting callus. The mercury was therefore omitted, and a splint applied. It is needless to say that the arm and the infant grew rapidly worse, the left arm also becoming helpless.

The true nature of the disease was then explained to the woman, the splint was removed, and a vigorous course of mercurial treatment was carried out with the infant; and to-day you see the rapid improvement which is taking place.

Here again we had to deal with one of the osseous lesions of syphilis, an *osteochondritis* accompanied by periostitis, which caused so much pain on movement as to disable the limbs and simulate both paralysis and fracture.

The next case (Case 221, Plate VI.) is of remarkable interest, owing to the form and appearance of the efflorescence, which, though unusual, is so characteristic that it could represent no other disease than syphilis.

The infant is six weeks old. The mother states that she has been married about three years, has had two children, and has had no miscarriages. She says that the father is well and strong, and that neither of them have had any efflorescence on their skin.

The older infant is fourteen months old, and is healthy.

The younger infant is being nursed by its mother. At birth it was apparently healthy and well nourished. Its skin was clear, its body fat, and there was no occlusion of the nares. This condition continued until it was eight days old. It then began to have occlusion of the nares (snuffles), a slightly hoarse voice, and an efflorescence on its back. To-day you see that it has an efflorescence on various parts of the body and limbs. This efflorescence consists mostly of maculæ, many of which are circumscribed by healthy skin. They vary in size from 0.6 to 1.25 cm. ( $\frac{1}{4}$  to  $\frac{1}{2}$  inch).

The lesions can be studied well by examining the right leg and foot, where their appearances are most clearly depicted. In order to see the exact color and distribution of these lesions, which at present are much obscured by dirt, I shall first have the leg and foot thoroughly washed with soap and water. This can be done without removing their characteristic appearances, since they are but slightly squamous, and, being mostly macular, can best be studied when the skin has been washed clean.

In addition to the maculæ, which you see varying from a delicate pink to a yellowish-white color, is a pustule on the outer side of the leg just below the knee. On the inner edge and almost on the back of the foot are the remains of a bleb which has broken down and has been emptied of its contents. There is also on the inner side of the foot, nearer to the heel, a small ulcer. All the other lesions are maculæ, and you see how distinct are these red maculæ on the sole of the foot. The entire skin of the heel is reddened and has a shining appearance. The erythematous lesions in places on the leg are surrounded by normal skin, presenting a mottled appearance, and there are white spots on the skin. These latter, however, are caused merely by the peculiar distribution of the syphilitic maculæ.

In addition to these lesions on the leg there are a few ulcers on the buttocks, and in addition to the maculæ on the soles of the feet there are some on the palms of the hands. A few scales showing a squamous condition can be seen on the left leg, but this lesion is not a prominent one.

The eyes are not affected. There are a few fissures about the mouth, but no lesions of the buccal mucous membrane, and there are no gummata around the anus.

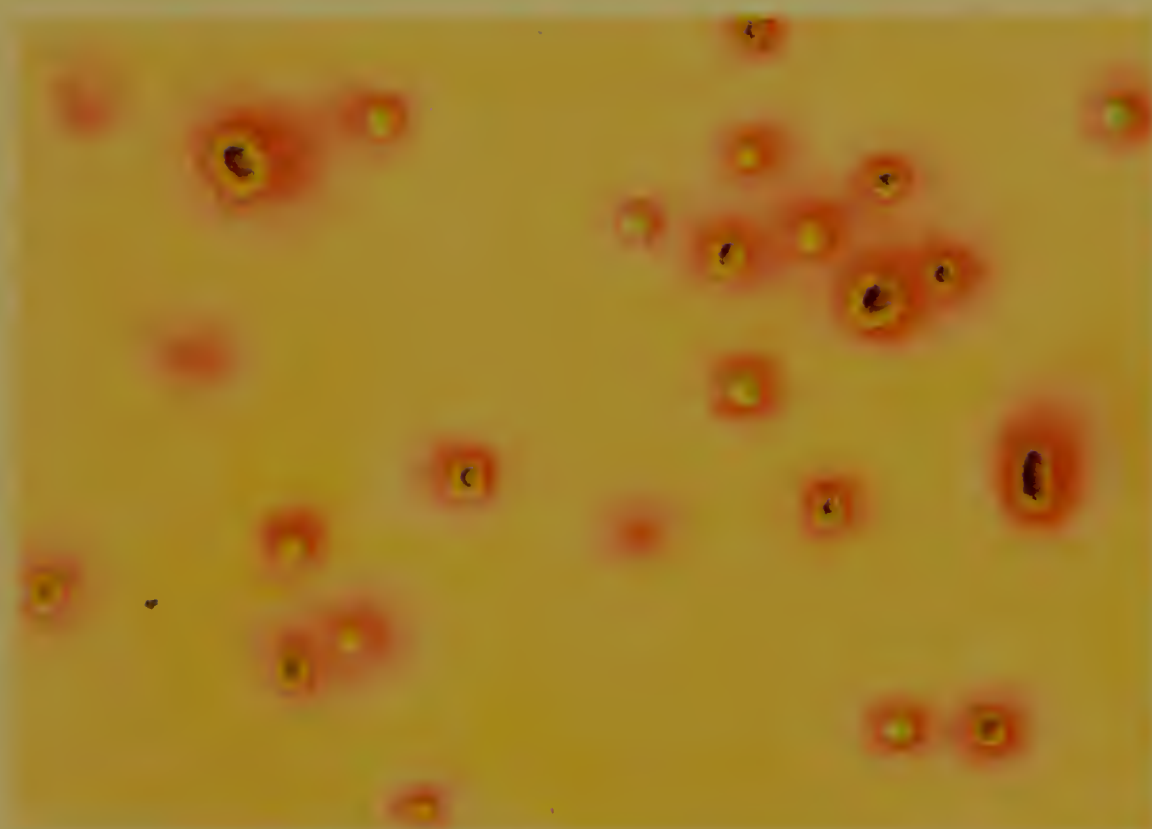
The treatment of this case will be by inunction with the oleate of mercury ointment, which I have already described (Prescription 66, page 499), and by the administration of hydrargyrum cum creta.

THE LATER MANIFESTATIONS OF HEREDITARY SYPHILIS.—I have already told you, in speaking of the manifestations of hereditary syphilis which appear at birth, that these symptoms usually develop in the first three or four months of the infant's life. In certain cases of syphilis which are without doubt of the hereditary form, either no symptoms whatever are

PLATE VI



Erysipelas



Varicella



Syphilis





noticed in the early years of life, or they are so slight, or so lacking in the characteristics of syphilis, that it is sometimes impossible to recognize them as syphilitic lesions. The lesions of this late hereditary form correspond to the tertiary lesions of the acquired form. They appear in different periods of childhood or at puberty. These periods correspond to what I have already stated to be the time when a fresh outbreak of an attack of syphilis which has occurred in the early months of life is apt to take place. This is significant as leading us to suspect that the early symptoms of the disease have been overlooked rather than to believe that they did not occur.

The lesions of the bones hold a prominent place in these later manifestations of hereditary syphilis. These lesions may be in the form of a periostitis, or an actual necrosis of the bone may take place either in connection with a dactylitis or with a simple lesion of the osseous tissue in any of the bones.

As these later forms of hereditary syphilis merely represent the same conditions as are met with in tertiary acquired syphilis, we should expect the most varied lesions. In this late form of hereditary syphilis the bones of the nose are frequently involved, and a flattening of the bridge of the nose is not uncommon. The cranial bones show certain alterations which at times are quite characteristic. The frontal bone may present a prominence on either side, which, with a depression more or less deep between the prominences, causes such a peculiar conformation of the head as to be almost characteristic of syphilis. This is well represented in the case (Case 225, page 510) which I shall presently show you. In addition to these frontal prominences, at times there is a prominence of the centre of the frontal bone, which, with the apparent flattening on either side, causes a peculiar shape simulating the keel of a ship. Sometimes protuberances similar to those which I have described of the frontal bone may appear on the parietal bones. When they are bilateral the sagittal suture appears as a depressed sulcus between them, and this deformity of the skull, from its resemblance to the shape of the nates, has been designated by Parrot as the *natiform* skull.

These tuberosities which I have just described as appearing on the skull may also appear upon the long bones, either in the diaphysis or in the epiphysis. When the tibia is affected there is often so marked an increase in parts of the shaft of the bone, especially its middle third, that, as the enlargement is chiefly in the anterior portion, the swelling when prominent gives an appearance of curvature to the bone. This is, however, only a seeming curvature, as the posterior portion of the bone is not affected.

An interference with the growth of children who are affected by these various osseous lesions of syphilis is not uncommon. There is frequently a lack of development, which shows itself usually in a failure of the individual to attain the ordinary height. The mental development is retarded, the children often appearing to be a number of years younger than they really are. This condition Fournier has designated as *infantilism*.

The first set of teeth in infants with hereditary syphilis have nothing characteristic about them; they show a lack of nutrition, a condition which may arise from many other morbid processes.

The second set of teeth, however, present certain characteristics. These characteristics are shown especially in the two middle upper incisors, in which the cutting edge of the tooth is worn away, leaving a convex surface with the convexity upward. The teeth are also apt to be somewhat far apart, and, as the child grows older, to assume a peg shape. The especial characteristics of syphilitic teeth were first described by Hutchinson. This peculiar shape of the teeth is not always present in syphilis, but when it appears it is certainly very suggestive of the disease. As was pointed out by Coleman, the dentist who examined Hutchinson's cases, in nearly every one of them there was a deficiency in the superior alveolar arch at the anterior portion, so great in some cases that when the jaws were closed the upper and the lower incisors did not come together.

I have already described the *onychia* which occurs as one of the earlier manifestations of hereditary syphilis. In the late form of syphilis another form of onychia is met with, characterized, according to Post, by a swelling at the base or the side of the nail, which becomes thickened, fissured, and brittle, with more or less deformity of the phalanx.

In the late form of syphilis a peculiar inflammation of the cornea at times appears. It usually begins with a cloudiness of the substance of the cornea, with ciliary congestion. The entire cornea in this way becomes clouded. The affection is not accompanied usually by pain, and does not show any special congestion of the conjunctivæ. Hutchinson says that it is always symmetrical, although at first it is apt to begin with one eye and later to attack the other. The interval between the two attacks may extend over several years. This disease is called *interstitial keratitis*, and may for a few weeks almost entirely abolish sight. It usually disappears under treatment without leaving any trace behind it. On the other hand, opacities are sometimes left and interfere with vision. The total duration of the disease varies from six to eighteen months. Interstitial keratitis, according to Post, occurs most frequently in female subjects, and is most common between the ages of ten and fifteen, although it may occur much earlier, and, according to Fournier, may even be met with at birth.

Complications may arise in the shape of iritis, choroiditis, and retinitis.

Disturbances of hearing may occur from a number of causes, especially as secondary to diseases of the pharynx. An especial form of *deafness*, however, without any special lesions to explain it, occurs in the syphilis of childhood, is usually intractable to treatment, and persists into later life. Extensive ulcerations produced by syphilis may occur in the *nose* and *pharynx* at any time during childhood.

TREATMENT.—The treatment of the lesions which usually occur in the retarded form of syphilis is essentially with iodide of potash, either alone or in combination with some mercurial. The iodide of potash should be



given at first in doses of 0.12 or 0.18 gramme (2 or 3 grains), and this dose should be gradually increased to 0.36 or 0.6 gramme (6 or 10 grains), or even more, as children often tolerate this drug remarkably well, and large doses are usually indicated.

When iodide of potash is given in combination with mercury, you can begin with corrosive sublimate in doses of 0.0006 gramme ( $\frac{1}{100}$  grain) and gradually increase the dose. Corrosive sublimate is, however, so apt to cause disturbance of digestion that I prefer to treat these cases by giving the iodide of potash uncombined with any other drug, by the mouth, and applying mercurial ointment to the skin.

The treatment of these later manifestations of syphilis must often be continued for long periods.

I have here, to illustrate the retarded form of syphilis, a girl (Case 222), thirteen years old. This case shows the importance of carefully reviewing the previous history not only of the child, but also of its parents.

The mother has had only this child, has never had any miscarriages, has always been well, and has never shown any manifestations of syphilis.

The father, so far as I can ascertain, until recently has always been well and strong, and has shown no signs of syphilis. About one year ago he began to have cerebral symptoms, which rapidly increased, were accompanied by paralysis, and were undoubtedly of syphilitic origin.

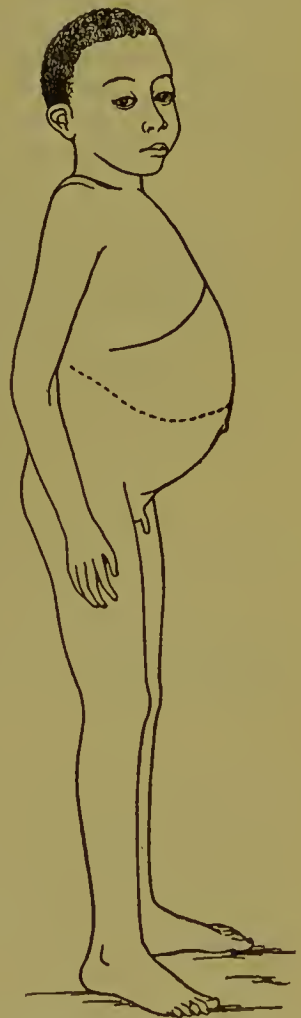
I was first called to see this child when she was suffering from a mild attack of appendicitis, which did not come to operation. At that time I noticed a peculiar conformation of the upper incisors, which made me at once suspect that I had under my care a case of hereditary syphilis. On further inquiry I learned that she had been treated some years earlier by an oculist for keratitis. The upper incisors, as you see (Diagram 7), are abnormally far apart and stunted in their growth. They are notched, as is also the left lateral incisor, which is peg-shaped and by its clearly-cut notch represents more nearly than the others the characteristic syphilitic teeth. The right upper lateral incisor has a peculiar shape, the crown of the tooth coming down almost to a point. The other teeth are, as you see, in many places deprived of their dentine, and are in various stages of disorganization.

On recovering from the appendicitis the child remained in a weak condition during the following year, looked sallow, and had continual headaches, which did not improve under the usual remedies. Treatment with iodide of potash has not only been followed by the disappearance of the headaches, but also has resulted in this healthy appearance of the child, who is perfectly well.

Here is another illustration of what is probably the retarded form of syphilis.

This boy (Case 223) is seven years old, and is a negro. His mother, who is said to be white, has had two miscarriages. The history of the father is not known, except that he was a negro. The boy has never had any disease, except measles when he was two or three years old. There is no history

CASE 223.



Probably retarded syphilis.  
Male, 7 years old.

of his ever having had any of the earlier manifestations of hereditary syphilis. When he was four years old he had what were described as epileptiform convulsions, and since then he has had three or four of these attacks. The attacks come on suddenly, and he is very somnolent after they have passed off. Ever since he was four years old his abdomen has been more or less distended. His appetite is good, his bowels are regular. He has lately been brought to the hospital to be treated for headache, a distended abdomen, and dyspnoea.

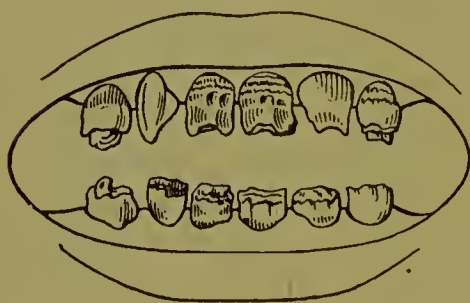
He has no enlarged glands, is not rhachitic, has no enlargement of the spleen and no ascites. The liver is found to be much enlarged, and, as you see, comes as low as the level of the umbilicus. Below the line of liver dullness the abdomen is resonant. The boy is mentally weak, and is very anæmic. On examination of his teeth you see that there are marked abnormal changes in the incisors. The upper four incisors are notched, dwarfed in size, and unnaturally far apart. The lower two middle incisors are also small and notched.

I have been treating this boy for the past month with hydrargyrum cum creta by the mouth and with mercurial inunctions. Under this treatment his general health has much improved, and he does not display the same degree of mental hebetude that he did on entering the hospital; he has also ceased to have the epileptiform attacks already referred to.

(Under the mercurial treatment the boy made a most decided improvement in his general health. The liver decreased in size, the digestion and appetite improved, and he gained steadily in weight and in mental development. He was discharged four months after entering the hospital, apparently perfectly well, except that there was still a slight enlargement of the liver.)

I have in this diagram represented twelve syphilitic teeth of the second dentition. They are all, as you see, more or less disorganized in a way

DIAGRAM 7.



Syphilitic teeth of the second dentition.

which might occur from any cause which would interfere with the normal development of the teeth and cause their early decay. The middle two and left lateral upper incisors show the notched and somewhat peg-shaped condition which is supposed to be characteristic of syphilis, and which you see I have copied from the mouths of the girl and boy whom I have just shown you (Cases 222 and 223).

As an illustration of these various tertiary lesions of syphilis, I will now show you a child who has been treated here in my clinic for some months.

It is a girl (Case 224), three and one-half years old. You will notice certain lesions on the face, arms, hands, and feet, which are the result of congenital syphilis. When this child was born it was apparently healthy. When it was three months old it was noticed to have occlusion of the nares, and at that time it had an attack of bronchitis lasting for three weeks. It is said that no efflorescence was ever noticed on its skin. When it was seven months old its hands began to swell, and at fourteen months the tissues around the metacarpal bones of the little fingers of both hands became reddened and ulcerated and the fingers assumed the pyriform shape characteristic of syphilitic dactylitis. When the child was about sixteen months old, the feet began to swell, and in certain parts, especially the metatarsal bones of the right foot, the skin became reddened. When the child was three years old, pieces of dead bone began to come away from the hands, and this has since continued. At this time also swellings began to appear over the upper maxillary bones, and, as you see, an extensive reddened and swollen condition of the tissues exists under the right

eye. The fontanelles are closed. There are evidently a periostitis and an osteochondritis of the right arm, and there is also an enlargement of the left ankle, accompanied by ulceration on the outer side of the malleolus.

CASE 224.



Late manifestations of syphilis. Female, 3½ years old.

The child has been treated with the combination of mercury and iodide of potash such as you see in this prescription (Prescription 68):

PRESCRIPTION 68.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Hydrarg. chloridi corrosivi . . .	0   03	R Hydrarg. chloridi corrosivi . gr. ss;
Potassii iodidi . . . . .	3   75	Potassii iodidi . . . . . ʒi;
Aq. destil. . . . .	60   00	Aq. destil. . . . . ʒii.
M.		M.

S.—2 c.c. (½ drachm) 3 or 4 times in 24 hours.

I have noticed that while it was taking this combination of drugs all its symptoms abated, it seemed better and brighter, and the lesions showed a tendency to heal. Whenever the medicine is omitted all the previous symptoms return. I should advise giving the child much larger doses of the iodide than are contained in this prescription.



The following case illustrates, among other interesting points, this same lesion of the bones.

The boy (Case 225) is six years old. You will notice that he is rather pale, and that he has a somewhat peculiar frontal development, which well illustrates the form of syphilitic head to which I have already referred (Case 218).

CASE 225.



Hereditary syphilis. Male, 6 years old. Abnormal prominences of frontal bone.

You see the slight depression of the bridge of the nose and the bulging of the forehead on either side just above the orbital ridges. These prominences are accentuated by the deep sulcus between them, extending from the depressed nasal bones upward almost to the margin of the hair. This condition represents the typical syphilitic head.

The boy is in fair health, and I can detect nothing abnormal about him on careful physical examination. His mother brings him to the clinic by my direction to receive, now that he is entering upon the period of the second dentition, a course of mercurial treatment for a few months. Possibly some iodide of potash may be given with benefit.

He is a case of probable recovery from hereditary syphilis, as up to the present time he has practically been cured. The various lesions of the bones and in the organs which it is necessary now to guard against correspond to the later lesions of acquired syphilis, and hence my reference to the use of iodide of potash, which in conjunction with mercury is of great value in these later manifestations of syphilis, and will be given to him in the form of the stronger chloride of mercury in combination with the iodide of potash.

The mother of this boy first brought him to see me at the Children's Hospital when he was six weeks old. The mother had been well and strong, and had never had any other children nor any miscarriages. The father had had a primary syphilitic lesion one year previous to the birth of the child, which was followed by secondary manifestations. The mother had plenty of good breast-milk, and nursed her infant until he was nineteen months old. The infant was never atrophic, and though pale was apparently well nourished. At birth he showed a bullous efflorescence of medium grade. During the early weeks of his life he did not receive any medical treatment, although he had a general efflorescence of

macules, pustules, and bullæ. At about the fifth week he lost the use of his left arm. When seen by me at the sixth week he showed a number of lesions besides those described, and it was doubtful if he would live. These lesions consisted of fissures at the corners of the mouth, mucous patches in the mouth, condylomata of the anus, and occluded nares. There was not at that time the peculiarly formed head which is now present. The left arm was helpless and was supposed to be broken; in fact, there was some crepitation, and probably there was a slight separation of the epiphysis of the distal end of the humerus. There seemed to be considerable pain in the arm, which made the infant restless and fretful. Insomnia was a prominent symptom. The arm was put in a light splint, and the oleate of mercury ointment (Prescription 66, page 499) was ordered.

The infant was then not seen for a week. On being brought back to the hospital the right arm was found to be helpless, and the mother stated that the ointment had been discontinued, as it caused excoriation of the skin. The ointment was then reduced one-half with lanoline, and hydrargyrum cum creta was given three times daily in doses of 0.06 gramme (1 grain).

In three days the infant was much better, the paralysis soon disappeared, and nothing abnormal was detected about the arms. The hydrargyrum cum creta was increased to 0.24 gramme (4 grains), but, as this caused diarrhœa, the dose in a few days had to be reduced to 0.18 gramme (3 grains). In the course of the next month the nasal symptoms and the efflorescence had disappeared, and the infant seemed perfectly well.

Six months later it was brought back to the hospital with a return of the condylomata and a slight papular efflorescence. The same treatment as before was carried out. The syphilitic manifestations disappeared, and have not returned since.

The child was kept under observation and treated from time to time for three or four years. The first teeth were cut at nine months, and, as you see, are in fair condition to-day.

In connection with this case, and for the purpose of aiding you in your differential diagnosis where an apparent paralysis is present, I would state that the possibility of the paralysis being a poliomyelitis anterior acuta was considered, but hardly seemed to explain the symptoms and the result, both arms being affected and entire recovery taking place three days after the mercurial treatment was properly carried out. Pain, also, would not have been present in a poliomyelitis. A central lesion was then thought of, but the rapid recovery from the paralysis before the efflorescence or the occluded nares had begun to be affected seemed to show that such a lesion did not exist. The evident pain experienced by the child when the arms were touched, and the speedy disappearance of this sensitiveness, as well as of the paralysis, under mercurial treatment, pointed towards a lesion in the arms themselves. The infant did not choose to lift or use its arms, because moving them caused pain. No traumatic history could be obtained. Rheumatism occurring at six weeks of age and affecting a child in this peculiar way would be very uncommon.



## LECTURE XXIII.

## ERYSIPELAS.

THE term erysipelas is applied to an inflammation of the skin, subcutaneous tissue, and mucous membranes which has the following characteristics. It especially involves the lymph-spaces and lymph-vessels. It has a tendency to spread, and is attended by unusual swelling of the subcutaneous tissue and an intense red color of the skin or the mucous membrane. In addition to these local appearances it is accompanied by constitutional symptoms, which are mostly the result of a heightened temperature.

It is caused by a micrococcus which is found exclusively in the lymph-spaces of the skin. This organism is a streptococcus, and in all probability is identical with the streptococcus pyogenes. The former belief that there existed a special organism which caused erysipelas has not been supported by recent investigations.

The disease runs an acute course, is contagious, enters the individual through some abrasion of the skin or mucous membrane, and is self-limited. The most careful and complete work which has been done in studying this disease is by Fehleisen.

**PATHOLOGY.**—According to Delafield and Prudden, the tissues may be swollen by an accumulation of serous fluid. This fluid may be nearly transparent, or may be turbid from admixture with pus-cells. The pus-cells may infiltrate the tissues either sparsely or in dense masses. Sometimes vesicles are found on the surface, or there may be crusts. Sometimes more or less of the affected region is filled with abscesses or becomes gangrenous. In some cases, aside from the local lesions petechiæ are found in the serous membranes, and swelling of the spleen and parenchymatous degeneration of the kidneys and liver. When the mucous membranes are affected they show the same appearances as the lesions of the skin, except so far as these are modified by the different structure of the tissue. The disease may attack the larynx and upper air-passages and may result in œdema. Pneumonia may occur as a complication.

Although the different organs, such as the spleen, kidney, heart, and liver, at times show pathological changes, nothing characteristic of erysipelas has been found in these organs, but only such changes as may occur from a continued high temperature or as the result of sepsis.

Erysipelas may be divided into two forms, (1) *migrans*, extending from surface to surface, and (2) *ambulans*, occurring in different parts of the skin. It may also be *acute* or *chronic*.

In erysipelas *migrans*, which is the most common form, the whole surface



of the body may be attacked. It is very prone to return, passing over the same surfaces of the skin again. The face and head are not so commonly attacked in infants as in adults, and the disease seldom spreads from another part of the body to the head. When it does attack the head, it is apt to be fatal from a secondary purulent meningitis. It at times causes great swelling and tension, and may go on to gangrene in certain localities, such as the scrotum.

After the first year erysipelas so closely resembles the disease as it occurs in adults that we need not consider it in this later period of life. It is a somewhat frequent disease in infants up to six months of age. It then becomes less frequent up to the first year, and after that and in childhood is rather rare. I shall, therefore, speak of erysipelas as it affects infants only.

The erysipelas of infancy may be divided into (1) erysipelas of the new-born and (2) erysipelas of sucklings.

**ERYSIPELAS OF THE NEW-BORN.**—Where erysipelas occurs before the end of the third week the infant seldom lives, and indeed it is a most dangerous disease up to the end of the third or fourth month. Erysipelas of the new-born is apt to occur during an epidemic of puerperal fever. If the mother has any septic symptoms, the infant should be immediately taken away from her. I have seen a case where the mother had puerperal peritonitis following her delivery and where the infant (Case 226), who was allowed to nurse her, was attacked by erysipelas.

In many cases occurring in the early days of life the disease starts on the genitals, and may be complicated by other diseases, such as empyema and especially pneumonia. During the course of the disease the fontanelle sinks, the spleen is enlarged, convulsions may occur, and peritonitis accompanied by vomiting may arise as a complication. The disease is liable to invade the tissues at any point of abrasion, whether from the forceps or from vaccination, or at the point of separation of the umbilical cord. The latter is the most common locality for the infection to take place. From this point the infection may extend and produce a gangrenous condition of the stomach or abdomen.

Although the temperature in the early hours or even days of the disease may not be raised, yet, as a rule, fever soon appears, the temperature varying from 39° to 41° C. (102.2° to 105.8° F.). Reddening and swelling, not of a high grade at first, appear on the parts affected. The infants show symptoms of a general sepsis. Vomiting frequently occurs, followed by collapse and almost without exception by death.

**TREATMENT.**—The treatment of this severe form of erysipelas is by stimulants and a substitute food adapted to the infant's digestion.

**ERYSIPELAS OF SUCKLINGS.**—The stage of the *incubation* of erysipelas lasts, according to Osler, from three to seven days.

When the disease occurs in the early months of life, its beginning is usually accompanied by cold extremities and collapse. The temperature is raised, and the higher its degree the graver the prognosis. The temperature

curve, as a rule, shows a zigzag course, except in the more severe forms, where there is continued high fever with which icterus is apt to be combined.

The efflorescence, although very similar to that which is seen on the adult's skin, differs somewhat on account of the more delicate structure of the infant's skin. It begins as a faint erythema, which spreads rapidly and as quickly disappears, perhaps in twenty-four hours, and twenty-four hours later desquamation may occur. The light color of the efflorescence soon becomes darker and more intense, and is accompanied by swelling, heat, and tension of the subcutaneous tissue. After the efflorescence has continued for a certain number of days, depending upon the amount of the surface of the skin involved, the extension of the disease ceases and the temperature falls. The redness gradually disappears, and the skin becomes covered with yellowish-brown crusts. Finally, desquamation takes place, and the skin recovers its normal appearance, the disease extending over a variable period according to the greater or less extent of the surfaces invaded.

Although the disease when involving large surfaces is dangerous, yet cases in the later months of infancy recover even where the attack has been a severe one. An instance of this kind came to my notice where an infant ten months old was attacked with erysipelas, the point of infection being the right labium.

In this case (Case 227) the whole vulva shortly became very tender and the disease extended to the pubes and abdomen. It invaded every part of the body and extremities and the head and neck. The eyelids and lips were the last points of attack. Even the palms of the hands and soles of the feet were affected. From the time that it appeared at one part of the body until the skin of that part assumed its normal color again was four days. When the erysipelatous inflammation extended to the feet there was marked œdema. The duration of the attack from its first appearance at the vulva to its disappearance at the eyes and mouth was about fifteen days. The infant was treated with small doses of iron and quinine, and recovered entirely.

**TREATMENT.**—No treatment of which I know is of any avail in cutting short the disease. Where large surfaces are affected, the application of cold compresses tends to depress the vitality of the infant, which it is so important to sustain. During the height of the disease the infant's strength should be supported by stimulants and by the frequent administration of a food adjusted to its digestion.

I have here an infant (Case 228, Plate VI., facing page 504) six months old which represents the typical efflorescence of the erysipelas of sucklings.

It is a female, has always been healthy, and was nursed by its mother until within the last three weeks, when it was weaned from the mother and nursed by another woman. It is of normal weight and general development.

The first symptoms which were noticed were that it began to vomit and to have a raised temperature, 39.5° C. (103.5° F.) in the axilla. It seemed weak and languid, looked badly, and refused to take the breast. An examination of the breast-milk showed a peculiar green color, which not only appeared in the milk when drawn from the breast, but also, when the analysis was made, appeared in the curd resulting from the precipitation of the proteids.



The analysis (Analysis 60) of the milk was as follows. The nature of the micro-organism which produced the green color was not determined.

## ANALYSIS 60.

Fat . . . . .	4.56
Sugar . . . . .	6.36
Proteids . . . . .	3.46
Ash . . . . .	0.13

Later in the day a pink efflorescence appeared just above the pubes, and there was found to be considerable irritation in the neighborhood of the vagina. The redness extended from the vagina to the supra-pubic efflorescence. The efflorescence was of an erythematous type. On the following day it spread to the left thigh, and then to the left lower leg. The temperature continued to be raised, and the infant refused to nurse. Small quantities of a substitute food with the following percentages (Prescription 69), which had to be varied from day to day, were given to it:

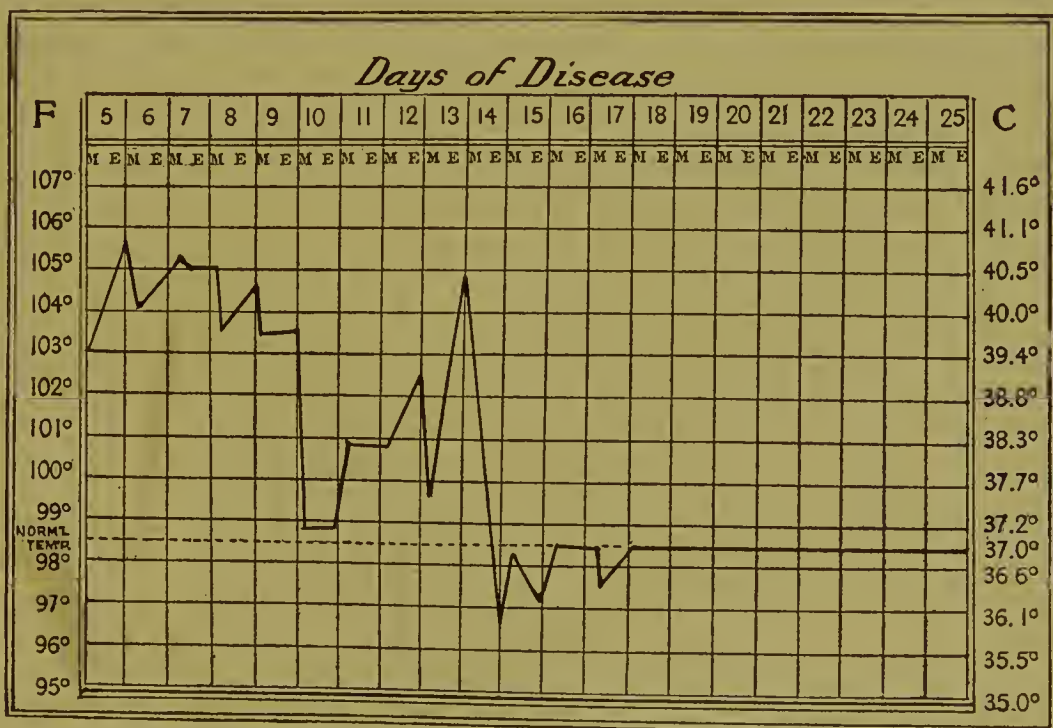
## PRESCRIPTION 69.

Fat . . . . .	2.50
Sugar . . . . .	6.00
Proteids . . . . .	1.50

There were no convulsions or other symptoms, but the infant lost somewhat in strength and weight and its face looked pinched.

The efflorescence on the left leg began to fade on the ninth day of the disease, and on the tenth day the temperature became almost normal. On the following day, however, it again rose, and a fresh efflorescence began to appear on the right thigh continuous with the

CHART 10.



Erysipelas of legs. Female, 6 months old.

efflorescence of the supra-pubic region. This efflorescence extended down the right leg to the ankle, and you see the condition of it to-day.

You will notice certain points in regard to the efflorescence on the left leg. A slight amount of redness is present, but it has mostly disappeared, leaving the skin in parts in an almost normal condition, in other parts covered by thin brownish-yellow crusts. The supra-



pubic region and the right leg as far as the ankle are, as you see, covered with a bright red efflorescence sharply bounded by normal skin below, just above the ankle, as though it were a stocking. The whole leg is swollen, is hotter to the touch than the sound skin, and presents a somewhat raised, glistening appearance.

No external applications and no drugs have been employed in this case. The milk has been carefully modified, and small doses of brandy have been given.

(The subsequent history of the case is as follows. A few days later the temperature became normal, the efflorescence began to fade, desquamation subsequently took place, and the skin finally recovered its normal appearance. The infant gradually regained its strength, became perfectly well, and has had no return of the disease.)

Here is the chart (Chart 10, page 515) showing the temperature during the course of the erysipelas in this case.

This form of erysipelas may become chronic, and this is more apt to occur in children than in infants. It is also most common in children who are in a debilitated condition, and may occur at intervals of three or four years. It is frequently in older children connected with chronic inflammations of the Schneiderian membrane, and in these cases is peculiarly intractable to treatment.

## LECTURE XXIV.

## THE EXANTHEMATA.

## VARIOLA—VARICELLA.

IN contradistinction to the various diseases of the skin which dermatologists are accustomed to designate as exanthems of local origin are certain acute, specific, infectious diseases which they call the exanthemata. This class of cases is of especial interest in connection with diseases which arise in children, as it is among children that they most frequently occur. They can, however, attack individuals of any age. Although none of these diseases are entirely self-protective, yet the instances in which they develop in an individual more than once are rare.

The exanthemata comprise five diseases,—variola (small-pox), varicella (chicken-pox), scarlet fever, measles, and rubella. In regard to the latter there is a question whether it is a disease distinct from measles.

This group of diseases is characterized by certain conditions common to all. Besides being infectious, each disease runs a definite course and is self-limited, facts which should be remembered when we are studying its diagnosis and treatment.

The course of these diseases from the time when the infection takes place up to the appearance of their later manifestations may be divided into distinct stages. In the first of these certain micro-organisms are supposed to enter the system, and, so far as external appearances and general symptoms are concerned, to remain dormant for a time, constituting what is called the *stage of incubation*. This stage of incubation is followed by certain general symptoms resulting from the supposed development of the special organisms and constituting the *prodromal stage*. These prodromal symptoms are, after intervals varying according to the special disease, followed by an efflorescence on the skin, which marks the third stage of the disease, called the *stage of efflorescence*. The efflorescence in its turn is followed by what is called the *stage of desquamation*, this desquamation being more or less pronounced in proportion to the intensity of the lesions of the skin which have occurred during the stage of efflorescence.

Although in a large number of cases the diagnosis of these diseases can be determined by the appearance of the efflorescence and its location, yet instances occur not infrequently where the efflorescence is very misleading. We should, therefore, be familiar with the characteristics of the other stages of these diseases, for it is by carefully considering the pictures which they present to us as a whole that we are enabled to make a correct differential diagnosis of the especial case. Thus, a papular efflorescence, although signi-

ficant in most cases of measles, may also be present in any other member of the group, while an erythema closely resembling scarlet fever may occur in variola, measles, or rubella.

**VARIOLA (Small-Pox).**—The first disease of this group which I shall speak of is variola. Variola is one of the most virulent of the infectious diseases with which we have to deal, and is particularly fatal among infants and young children. It is an acute disease, caused evidently by a micro-organism. It is characterized by severe constitutional symptoms, accompanied by a progressive efflorescence from macules and papules to vesicles and pustules, followed by the formation of crusts, these lesions having a tendency to result in cicatrices. As I have stated to you in a previous lecture (Lecture V., page 147), since vaccination has been established, variola, in contradistinction to variella, scarlet fever, and measles, is an extremely rare disease among infants and young children who have been vaccinated.

Although there are no characteristics of variola which are distinctive in children from those of the disease occurring in adults, it is important to recognize its chief features for the purpose of differential diagnosis. It is possible for the fœtus to contract the disease in utero. This, however, is rare, and it is well known that infants whose mothers are affected with variola can, even when born in small-pox hospitals, be protected from the disease if vaccinated immediately. It is rather remarkable that the micro-organism which causes variola has never been discovered, when we consider for how long a time the disease has been known to be highly infectious. The contagium is supposed to exist in the secretions and excretions, and to emanate from the exhalations of the lungs and from the skin. It is in all probability transmitted principally by means of particles of the crusts. It has a wonderful tenacity for clothing or any like means of conveyance. It has been proved that the contagium is active before the efflorescence occurs, though not so much so as later. It has also been fairly well proved that its activity ceases when all the crusts have fallen off and when the entire skin has become smooth. The most virulent form of the disease can be contracted from a mild form, such as varioloid.

**PATHOLOGY.**—The pathological conditions found in variola are chiefly those of the skin and the mucous membranes.

According to Weigert, the progressive changes of the lesion of variola are as follows. The lesion begins as a round, somewhat raised macule. This develops into a hard papule, and later a small vesicle arises on its summit. This vesicle enlarges very rapidly and changes to a tensely filled pustule with a central depression. The size of this pustule corresponds to that of the original macule. Microscopically the macule consists of a circumscribed spot of hyperæmia in the capillary layer of the skin. The papule is formed by a sharply defined necrobiotic degeneration of the under layers of the rete mucosum, by which process the nuclei of the epithelial cells are destroyed. By the transudation of fluid into these areas the cells are pushed apart and the epithelial layer is lifted up as a whole, covering the area



affected, and forms a vesicle the inner part of which is composed of a mesh-work filled with lymph. In the vicinity of the necrobiotic focus an inflammation is set up, causing an increased growth of the cells of the rete which surround and wall in the focus on all sides. The developed pustule extends through the whole thickness of the cutis to the subcutaneous tissue. A network inside the pustule, which is most tense in the central part, connects the roof and floor of the pustule, and, in conjunction with the above mentioned growth of the cells of the rete around the focus, causes the central depression. If the vesicle is pricked, only a part of the lymph flows out of the mesh-work within. The lymph is clear, and contains some white and red blood-corpuscles, streptococci and staphylococci, fibrin-flocculi, and molecular granules. The contents of the pustule are purulent, and those in the hemorrhagic form contain blood. Clumps of bacteria with analogous localized degeneration and its associated changes are found in the neighborhood of the pustules, also in the parenchyma of the internal organs and lymph-glands, as well as in the skin. When the variola has reached its height the central depression in the pustule disappears, because the increased tension in the contents tears away the mesh-work. The vesiculation begins in the upper central part and spreads downward towards the periphery. The pustule then collapses and changes to a crust, which after a certain number of days falls off, leaving a more or less deep scar covered with young epithelium. A distinct difference in the anatomy of a pustule of variola vera and one of varioloid does not exist.

On the mucous membranes of the mouth, nose, conjunctivæ, bronchi, œsophagus, rectum, sometimes the vagina, and also on the tonsils and the tongue, the same pustular efflorescence may be found, and is either superficial or extends more deeply. At times also a pseudo-membrane is found on the ulcers.

According to Osler, the papillæ of the true skin below the pustules are swollen and infiltrated with embryonic cells to a variable degree. If the suppuration extends into this layer, scarring invariably results; it does not necessarily follow if the suppuration is confined to the upper layer.

In the intestines swelling of Peyer's follicles is not uncommon. In the larynx the efflorescence may be associated with a fibrin exudate, and sometimes with œdema sufficient to cause death. Occasionally the inflammation extends deeper and involves the cartilages. In the trachea and bronchi there may be ulcerative erosions, but the characteristic lesions seen on the skin do not occur. There are no special lesions of the lungs, but congestion or broncho-pneumonia is very common.

According to Gardner, in addition to the conjunctiva almost every part of the eye may suffer, the lids, lachrymal sac, cornea, choroid, and even the retina and extrinsic muscles.

These complications may occur either during the course of the disease or afterwards.

According to Adler, keratitis may develop from a purulent conjunctivitis,

or quite independently of it, never, however, earlier than the twelfth day. It may occur as a circumscribed superficial inflammation which, even under atropine and hot fomentations, may take the form of an ulceration very dangerous to the eye.

In the ear, according to Wendt, complications are more frequent than in the eye. The milder forms of hyperæmia are generally overlooked, as they cause no symptoms. Congestion of the middle ear is common, and is generally directly due to swelling of the naso-pharyngeal mucous membrane closing the Eustachian tubes. Sometimes this progresses to acute inflammation of the middle ear, which may end in extensive destruction of the soft parts, with subsequent permanent deafness.

According to Osler, in exceptionally rare cases the eruption extends down to the œsophagus and even into the stomach.

The pathological changes in the other organs consist of enlargement of the spleen and fatty degeneration of the liver, kidneys, and heart. Metastatic processes in the various organs and in the joints sometimes occur. In the hemorrhagic form hemorrhages in the various cavities in the different organs, and, according to Golgi, in the medullary cavities of the bones, may occur, also in the serous and mucous surfaces and in the muscles.

**INCUBATION.**—The incubation of the disease varies from twelve to fourteen days, the latter being the most frequent period.

**SYMPTOMS.**—According as the symptoms of variola are mild or severe the disease has been divided into a number of forms, designated as follows: (1) *discrete*, (2) *confluent*, (3) *hemorrhagic*, and (4) *modified*. In all these forms the initial fever, convulsions, and general symptoms may be severe, and do not necessarily indicate which type of the disease is about to follow.

(1) **DISCRETE.**—The mildest and most typical form of the disease is that which is called *discrete*.

**Prodromata.**—In this form, the invasion, though sometimes less severe than in the confluent and hemorrhagic forms, as I have just stated, in infants and young children is almost always of a grave type. In infancy and early childhood the disease commonly begins with convulsions. There may be vomiting, great restlessness, quick pulse, high temperature, and in a number of cases the children quickly succumb to the disease from the virulence of the toxæmia. If they survive this early stage of the disease they usually present the same sequence of symptoms as in cases occurring in later life, but may eventually die from the exhaustion which often rises from a prolonged suppurative fever. In the prodromal stage the pulse is much quickened, and the temperature may be as high as 40°, 40.5°, or even 41.1° C. (104°, 105°, or 106° F.). In this stage we at times, especially among children, meet with an evanescent erythematous efflorescence. According to Simon, this manifestation is distinct from that of scarlet fever. It has a peculiar distribution and generally a limited extent, usually affecting the lower abdominal areas, the inner surface of the thighs, the sides of the thorax, and



the axillæ; sometimes, however, it involves the whole surface. This efflorescence is distinct from the typical lesions of variola which occur later.

**Efflorescence.**—On the third or fourth day of the prodromal symptoms an efflorescence appears on the skin, and at this time the frequency of the pulse lessens, the temperature usually falls considerably, and the more severe symptoms improve, so that the patient appears much more comfortable. The efflorescence is at first represented by small red macules or papules, which, as a rule, first appear on the forehead, or on the face and mucous membranes, and later on the trunk and limbs. The papules are rather scattered in their distribution, and have a feeling as of shot under the skin. The macules when present soon become papules. On the third day by means of a good light a small vesicle can be seen at the apex of the papule, and by the fifth or sixth day the vesicular stage is well established and the vesicle becomes distinctly umbilicated. This appearance on careful examination can also be seen in the lesions of the mucous membranes. At about the eighth day the vesicles become pustules, the tops soon flatten, and the umbilication disappears, leaving an areola of injection and the intervening skin swollen.

The temperature at this time rises, from the suppuration which is taking place in the pustules. This rise of temperature is called the secondary fever, or fever of suppuration. The temperature remains high for from twenty-four to forty-eight hours, and then gradually falls until by the twelfth or thirteenth day it usually becomes normal. The contents of the pustules dry up, and crusts are formed. On the palms and soles small hard disks form, which may of themselves fall off in infants, but in children as old as ten years would remain for a long time unless removed with the point of a knife.

**Desquamation.**—By the fourteenth or fifteenth day the stage of desquamation is established. In some cases extensive scars are left on the skin where the crusts have fallen off. This is most apt to occur in severe cases.

(2) **CONFLUENT.**—In contradistinction to the mild or discrete form of variola is the more severe form, called *confluent*, on account of the tendency of the lesions to coalesce. In the confluent form of variola the efflorescence usually appears at the same time as in the discrete form. At about the fourth day the lesions become confluent, the skin becomes reddened and swollen, and the face may be much distorted by the severity of the lesions. In this form the initial temperature does not fall to the same degree as it does in the discrete form, and, according to Sydenham, diarrhœa is likely to occur, particularly in children. The pharynx and larynx are especially apt to be involved, and the cervical lymphatics to be enlarged. The crusts adhere longer in the stage of desquamation than they do in that of the same stage of the discrete form.

(3) **HEMORRHAGIC.**—The third or *hemorrhagic* is the most virulent form of variola, and may occur in children as it does in adults, though not so frequent in the former as in the latter. Its symptoms in children are so severe that in almost every case it very quickly proves fatal. It is charac-



terized by punctiform hemorrhages in the skin, appearing from the first to the fourth day of the prodromal stage, ecchymoses in the conjunctivæ, and hemorrhages from the mucous membranes. According to Osler, hæmaturia is the most common form of hemorrhage, hæmatemesis the next.

(4) MODIFIED FORM.—The fourth or *modified* form of variola is where the disease attacks individuals who have been successfully vaccinated. This form is called varioloid, but would be better termed “modified small-pox.” Modified small-pox is usually much milder in its symptoms than any of the other forms of variola, although the initial fever may be as high as in a severe case. The papules are fewer in number, the temperature becomes normal sooner, and the child seems comfortable in a shorter period of time, since there is usually no secondary fever from suppuration. The nearer the attack comes to the time when the child was vaccinated, the less severe will be the symptoms.

In any of these forms of variola the prodromal symptoms may be of a very severe nervous type, and this is especially characteristic of the disease as it occurs in children. For this reason variola may simulate other diseases in its prodromal stage, and may often cause death before the efflorescence has appeared. This is especially the case with the prodromal symptoms of the hemorrhagic form.

COMPLICATIONS.—The most common complications of variola are those of the larynx and the lungs. Where the larynx is affected, œdema of the glottis may suddenly arise and death take place from suffocation.

In the throat the presence of the efflorescence occasions great irritation, and the accompanying secretions cause nausea and at times dyspnoea, with a cough which in weak children is very exhausting.

Where acute inflammation of the middle ear has taken place the pain during the formation of the pus is very intense, but it subsides as soon as the sac bursts or is incised. This complication, therefore, requires early and careful treatment.

Where a lesion of the lung develops, it is usually in the form of a broncho-pneumonia. Lobar pneumonia rarely complicates the disease.

Although albumin is very frequently present in the course of the disease, nephritis is rare.

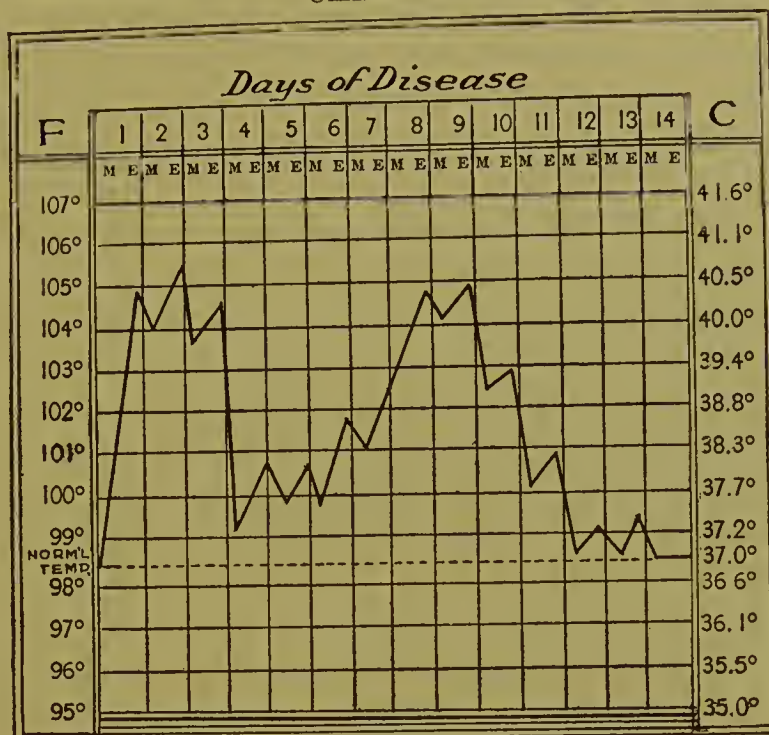
This chart (Chart 11, page 523) represents the usual temperature curve of the initial fever and suppurative fever of a typical case of variola.

DIAGNOSIS.—There is no other constitutional disease accompanied by an efflorescence on the skin which in a typical case would be likely to be mistaken for variola. The severe constitutional symptoms, the slowly developing and rather scattered macules and papules, with the shotty feeling of the latter, the umbilicated vesicles gradually becoming pustules, the extensive crust formation, and the initial and suppurative fever, all render the diagnosis in most cases quite plain.

In making the diagnosis of variola we should consider that the disease differs materially in its prodromal symptoms from varicella and measles.

The almost complete absence of prodromal symptoms in varicella, and the pronounced catarrhal symptoms of the nose and eye in measles, make the differentiation from these diseases comparatively easy. Although the prodromal symptoms of scarlet fever and of variola are often of equal

CHART 11.



Fever of invasion. Fever of suppuration.  
Variola

severity and somewhat similar, such as the convulsions and vomiting, yet the pronounced symptoms connected with the throat in scarlet fever, and the appearance of an erythematous efflorescence instead of the scattered papules of variola, serve to differentiate clearly the two diseases. We must, however, be careful not to mistake the evanescent efflorescence which I have already referred to as occurring in the prodromal stage of variola for the erythema of scarlet fever. The distinction can usually be made by remembering that this efflorescence in variola affects the particular areas of the skin already referred to, and that these areas in scarlet fever, measles, and varicella are unlikely to be affected early in the stage of efflorescence. The typical location of the efflorescence of scarlet fever is first on the neck and chest, that of measles on the face, and that of varicella on the back, face, and head.

In making the diagnosis of variola we must, of course, bear in mind the efflorescence which appears on the skin as the result of *vaccination*, and that which occurs in the course of the disease *vaccinia*. In vaccination the single lesion and the absence of severe constitutional symptoms make it hardly necessary to do more than refer to it in this connection. The differential diagnosis from vaccinia is not difficult, and yet this disease is so rare that when it appears it almost always creates a suspicion that we may be dealing with variola. As a rule, in vaccinia the general symptoms are not severe,



the disease being represented almost entirely by a slight malaise and loss of appetite, in conjunction with the appearance on the third or fourth day of an efflorescence on the skin. This efflorescence, as I have stated in a previous lecture (Lecture V., page 152), is represented by papules, vesicles, and pustules, few in number and irregularly distributed, some on the face and nose and a few on the body and extremities. As the disease almost invariably appears after vaccination, this fact is of great aid in differentiating it from variola. The subsequent course of a case of vaccinia is so much milder and shorter than that of variola that in a few days the differential diagnosis can be made easily.

**TREATMENT.**—There is no specific treatment for variola, but it is of the utmost importance that the best hygienic care should be employed. The air of the room should be perfectly fresh. The crusts should be kept softened with a mixture of glycerin, oil, and carbolic acid, and the odor arising from them should be modified by the application of a dilute solution of carbolic acid.

In the initial stage of the disease stimulants should be freely given if the symptoms are severe, and the high temperature should be controlled by sponging with water at a temperature corresponding to the power of the child's reaction.

The greatest care should be taken during the stage of convalescence, and when the child is considered well the most rigid measures for preventing the spread of the contagium should be enforced. The clothing and everything connected with the child and its attendants, and the room in which they have been kept during the sickness of the child, should be thoroughly disinfected, the same precautions being taken to prevent the spread of variola that I shall presently describe to you in speaking of scarlet fever (Lecture XXV., page 549). The immediate transference of a patient from its room to a small-pox hospital is in most communities considered the wisest method of dealing with the disease, and is usually enforced by law.

**VARICELLA** (Chicken-Pox).—The next member of the group of exanthemata which I shall speak of is varicella. It is the mildest in its symptoms and the most favorable in its prognosis of the whole group. It is highly infectious, and is characterized, in distinction from the other exanthemata, by its long stage of incubation, the shortness or absence of the prodromal stage, vesicular efflorescence, and absence of sequelæ. Varicella has been known as an independent disease for the last two centuries. At one time it was not clearly differentiated from measles and scarlet fever, and in some parts of the world it is supposed to be closely allied to variola. This opinion, however, is not generally substantiated, and we can accept varicella as a distinct disease.

It can occur at any age, but the most common time for its appearance is in the middle and latter part of the first year. It continues to be a common disease all through the early and middle years of childhood. The susceptibility to the contagium of varicella lessens after ten years of age, and almost disappears at puberty. It is sometimes sporadic and sometimes epidemic.



It occurs with equal frequency at all periods of the year. The vehicle of contagium is not known, but it probably enters the system by the lungs. The specific organism which produces varicella has not yet been determined.

**PATHOLOGY.**—Deaths from varicella are so extremely rare that our knowledge of the pathology of the disease is necessarily limited. It is evident, however, that the efflorescence of vesicles, which represents the principal morbid lesion of the disease, is of a somewhat different type from that which occurs in variola. The vesicle is much nearer the surface than in the latter disease, being formed mostly by the upper layers of the epithelium. The vesicle itself is seldom multilocular, a condition which is frequently present in variola. The contents of the vesicles are usually a clear serum, the progression to a pustule being rare in comparison with the lesion of variola. The lesion so rarely involves the deeper layers of the skin, and the process is usually so very mild, that it is seldom that sufficient destruction of the tissue takes place to produce a scar.

The lesions may appear on the mucous membranes as well as on the skin. At times the lesions assume a much more serious form and may become gangrenous. In *gangrenous varicella*, according to Eustace Smith, the vesicles, instead of drying up in the ordinary way, become black and larger, so that a number of rounded black crusts are scattered over the surface of the body. If a crust be removed, it is found to cover an ulcer more or less deep. Around it the skin is of a dusky red color. All the vesicles do not become gangrenous, so that we find crusts of the ordinary appearance mixing with the blackened crusts. The gangrenous process often penetrates deeply through the skin to the muscles. The lesions at times are so extensive as to form ulcers which may invade and destroy large areas of tissue.

**INCUBATION.**—The stage of incubation is variable, but lasts from eight or ten days to three weeks, the usual time being about seventeen or eighteen days.

**SYMPTOMS.—Prodromata.**—There are rarely any prodromata in varicella, beyond a slight malaise for a few hours. At times, however, especially in young infants, the onset of the disease may be severe: it may be characterized by vomiting, and, where the temperature is high, even by convulsions. In rare cases the prodromal stage is of considerable length and the prodromata resemble somewhat those of the other exanthemata.

**Efflorescence.**—The disease usually shows itself in the form of an efflorescence, the characteristic and most common lesion of which is a vesicle. The lesion, however, is in the beginning a macule, which quickly becomes a papule, and the papule so rapidly develops into a vesicle that it is in the vesicular stage that we usually first notice the efflorescence. These macules and papules are so superficial that they are soft to the touch and do not give the shotty feeling which is so common in these lesions when they occur in variola. The vesicle of varicella, as a rule, is not umbilicated, and but rarely do its contents become pustular. It may be surrounded

by a light red areola, but this is not present in all the lesions. The usual course of progression in the lesions is that the vesicle flattens, its contents are dispersed on the skin or absorbed, and a small crust is formed, which finally falls off, leaving the skin smooth and without a scar. Occasionally a scar results from some individual lesion in which the inflammatory process has involved the deeper layers of the skin. The efflorescence is irregular and general in its distribution, the lesions appearing on the face and head, in my experience especially behind the ears, on the body, usually first on the back, and finally on the extremities. It comes out in successive crops, so that very different lesions may be found on the skin at once, representing the early and late manifestations of the efflorescence. It, however, may first appear in the throat, but is not so often seen in this location as is the efflorescence of scarlet fever or measles. It is possible that the efflorescence always appears first in the throat, but that in many cases it is not seen early enough to be recognized, as the manifestations are very evanescent.

This efflorescence of variella is almost the only one which is characteristic of a specific disease. By this I mean that while a vesicle does not necessarily allow us to diagnose any disease of the skin, yet when these vesicles with their areolæ, in combination with constitutional symptoms, appear in groups in different parts of the body, there is no other disease with which we should be likely to confound it, with the exception of variola, vaccinia, and possibly herpes zoster.

The course of varicella is rapid. It is characterized by a sudden onset of constitutional symptoms, with the almost immediate appearance of the efflorescence. The efflorescence runs a rapid course, appearing quickly on different parts of the skin, and disappearing almost as quickly as it appears. The disease lasts about a week or ten days, and, as a rule, has no serious sequelæ. It is rarely complicated by any other disease.

COMPLICATIONS.—During the course of certain epidemics, however, it has been noticed that the kidney is affected. This complication usually occurs after the efflorescence has almost disappeared, and in the second week from the time of the beginning of the attack. In these cases albuminuria is present, and in all probability is caused by some form of nephritis, although nothing definite is known about this class of cases.

GANGRENOUS VARICELLA.—A complication which at times arises in variella is what is called the gangrenous form of varicella, the pathology of which I have already described. Although it is most common in ill-nourished children, yet it does not necessarily attack this class of cases, and it seems to have some connection with the gangrenous processes which certain individuals show a tendency to develop.

PROGNOSIS.—The prognosis of varicella is usually, unless the above-mentioned complications arise, extremely favorable. Cases occur where the prognosis is rendered unfavorable by lack of proper care during the convalescence, resulting in broncho-pneumonia and other diseases. In some cases



the prognosis is rendered unfavorable by the anæmia which is apt to follow an attack of varicella, and is at times pronounced.

DIAGNOSIS.—The diagnosis of varicella is not difficult if we bear in mind the characteristics of the diseases which it is most apt to simulate.

In differentiating it from variola we must consider the great difference in the rapidity of the development of the efflorescence in the two diseases. In variola it is essentially slow, in varicella it is characteristically quick. The papules of variola are hard to the touch, those of varicella are soft. The vesicle of variola, as a rule, is umbilicated and soon becomes a pustule; these characteristics are absent in varicella. The whole course of variola occupies a period of from two to three weeks; the course of varicella is much shorter, and is often limited to one week. Finally, the severe constitutional symptoms and the long prodromal stage in variola differ essentially from the lack of prodromata and the mild constitutional symptoms in varicella.

In vaccinia the slow progression of the lesions from papules to pustules, and the rather limited areas affected, serve to distinguish it from the successive crops of vesicles, with their rapid development and extensive areas, which are met with in varicella.

The differential diagnosis of varicella from herpes zoster is not difficult, if we consider that the vesicular efflorescence in herpes zoster follows the course of some set of nerves, while that of varicella is perfectly irregular and is in no way connected with the distribution of the nerves.

In this table (Table 93) I have arranged the chief points of difference between varicella and variola:

TABLE 93.

	Varicella.	Variola.
Incubation . . . .	Two to three weeks.	One to two weeks.
Prodromata . . . .	None or slight.	Three to four days in length. Active. Severe.
Efflorescence . . . .	On the skin. Rapidly becomes vesicular. Not umbilicated. Unilocular. Irregular. Numerous. Universally distributed in successive crops. Vesicles differ greatly in size. On pricking, collapses entirely.	Under the skin. A slow progressive development from a macule to a papule, from a papule to an umbilicated vesicle, then to a pustule. Multilocular. Regular. Not numerous. Defined in its localization. Lesions, as a rule, of uniform size. On pricking, collapses partially.
Desquamation . . . .	Slight crust formation.	Pronounced crust formation.
Duration . . . . .	Short, one week to ten days.	Long, three to four weeks.
Type . . . . .	Mild.	Severe.
Temperature . . . .	Irregular, not high.	Rises suddenly. Remains high until papules are developed, when it falls considerably. Rises again during the development of the pustules.



I have here a boy (Case 229) who was brought to the hospital a few hours ago, and who illustrates very well what I have told you concerning the efflorescence of varicella as it occurs in the throat.

He is said to have been well until yesterday, when towards evening he began to feel feverish, to have loss of appetite, and to complain of sore throat. He was brought to the hospital to be treated for a supposed cold. On examination nothing abnormal was found except these lesions which I shall show you in the throat, and a few vesicles behind his ears and on his back. These lesions on the skin have appeared since he came to the hospital, subsequent to those which were seen in his throat a few hours ago. On making the child open his mouth and depressing his tongue you will see certain lesions of the mucous membrane of the entire throat (Plate VIII., Varicella, facing page 781). The tongue, you see, is very slightly coated. The tonsils are not enlarged. The mucous membrane of the hard and of the soft palate and of the pharynx is slightly hyperæmic. On the upper and right side of the hard palate and very near where it joins the soft palate you will notice two small vesicles surrounded by a distinct red areola. To the left and below these lesions are three minute macules, two of which have almost become papules. You must remember that the difference between a vesicle and a pustule is simply one of degree. On the skin behind the ear and on the back you will notice that these lesions are purely vesicular. There are not so many leucocytes in the vesicles on the skin as are evidently present in the two lesions on the hard palate, which give the latter a yellowish color in contradistinction to the pearly white color of the dermal lesions.

This case illustrates very well the importance of making a thorough examination of the throat in children, which I have referred to in a previous lecture (Lecture XIII., page 323), for unless the throat had been examined the child would have been supposed to have a cold and would have been allowed to remain in the clinic and thus spread the contagium.

To illustrate still further the efflorescence of varicella, I happen to have in the isolating ward of the Children's Hospital a case in which the varicella is at its height and has been running its course for two days.

This child (Case 230, Plate VI., Varicella, facing page 504), a girl, was attacked with headache and malaise three days ago in the morning. In the afternoon an examination showed an efflorescence in the throat, but there was also a well-marked vesicular efflorescence on the back. This efflorescence soon began to come out in crops in different parts of the body, on the limbs, behind the ears, and on the scalp. There are also a few lesions on the face. Here on the back you will notice a number of lesions, some of which are simply macules, and again a few of the macules have become papules. In most cases, however, the lesions are distinctly vesicular, varying in their contents to such a degree that we sometimes see the pearly white appearance and again the yellowish color of a vesicle which has become somewhat pustular. In other places the vesicles have broken down and little crusts have formed in their centres, which are somewhat indented. On pricking one of these vesicles you see that it collapses and is emptied of its entire contents, showing that it is unilocular. The vesicle of variola when pricked in this way would in most cases be only partially emptied, showing that it was multilocular.

In this next bed is a little girl (Case 231) who shows the lesions of varicella in all these stages.

This child was brought from the surgical ward three days ago, and, as you see, was being treated with plaster-of-Paris bandages for an injury to the arm. The efflorescence, chiefly vesicular in character, first appeared behind the ears, and one or two of these lesions which have mostly run their course and have become crusts are, as you see, still present. The whole of the child's back is thickly covered with the efflorescence. The lesions are also on the arms, legs, and abdomen, and, although not so numerous on the front of the chest as on the back, they are very prominent in this area. The lesions have attacked the chin, lips, face, nose, and forehead, and can also be found on the scalp.

I shall order the plaster bandage to be removed, as a fixed bandage should never be

used during the course of any of the eruptive diseases, owing to the probability that extensive ulcerations will develop under them.

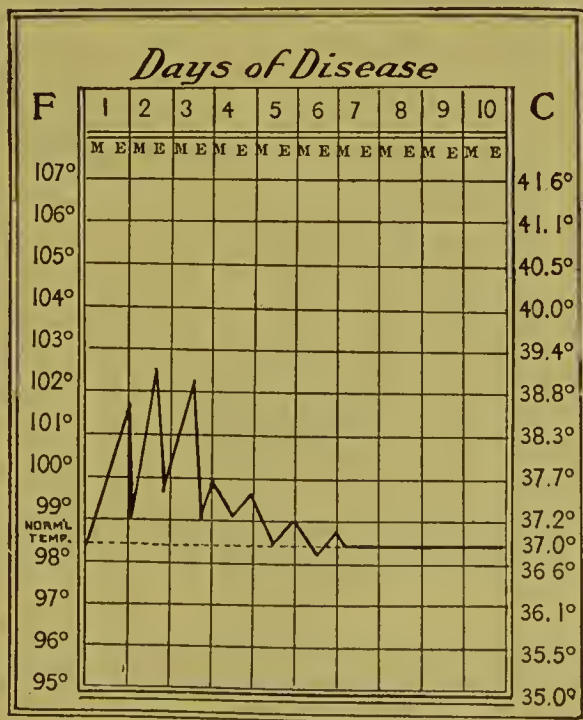
CASE 231.



Varicella. Stage of efflorescence, third day.

The temperature in varicella is in most cases not high, and is very irregular. It usually rises when a crop of lesions of any considerable number develops, and falls again at the outbreak. This chart (Chart 12)

CHART 12.



Varicella simplex.



shows the usual variations which you may expect to find in the temperature of varicella.

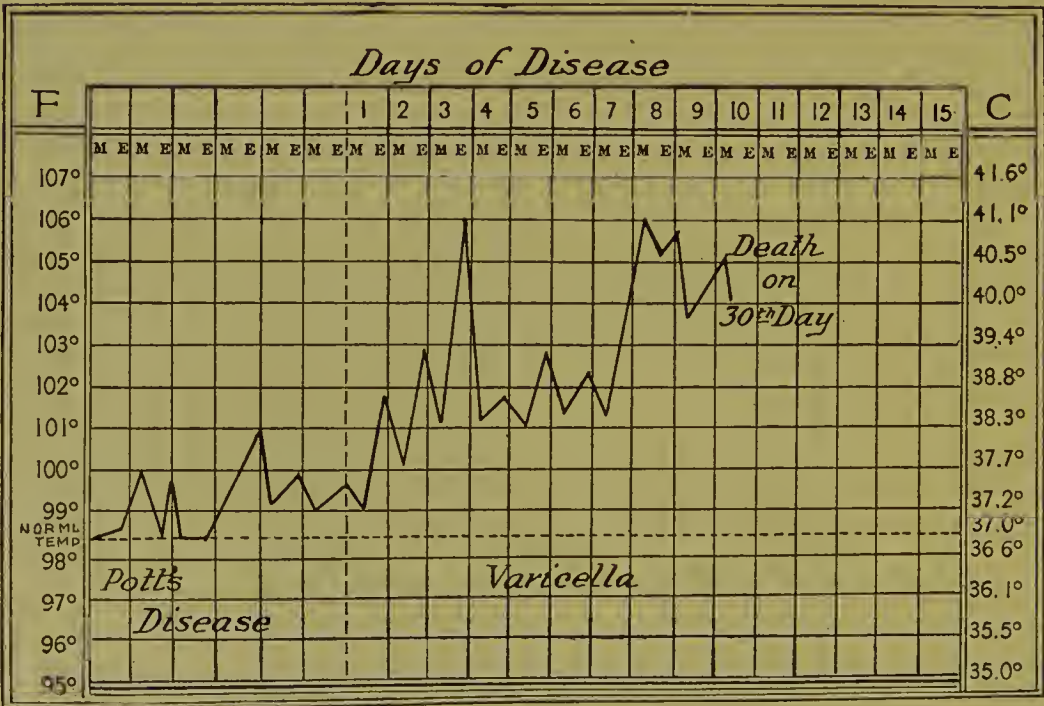
I have also here a child (Case 232), three years of age, who was brought to the hospital with Pott's disease, and with a paraplegia arising from a transverse myelitis caused by the disease. Nothing abnormal was found in connection with the lungs, heart, or kidneys. Until the child was attacked with varicella the temperature was usually normal, but sometimes rose to 37.7° C. (100° F.), and occasionally as high as 38.3° C. (101° F.).

About one month ago the child became restless, and his temperature rose somewhat. On the following day the symptoms became more marked, and the temperature was found in the evening to be 39.4° C. (103° F.). On this day an efflorescence of varicella appeared on his skin. During the third day of his sickness his face swelled, and in the evening his temperature was found to be 41.1° C. (106° F.). The vesicular efflorescence was well developed on his trunk and face by this time. Somewhat later it became universal and assumed a purulent character, especially about the face. During the fourth, fifth, and sixth days of the disease his temperature varied in the evening from 39° C. (102.2° F.) to 39.4° C. (103° F.). On the seventh day of the disease all the symptoms increased in severity, and the temperature was found to be 41.1° C. (106° F.). On this day some of the vesicles on the face had become ulcers. Nothing abnormal was found in the lungs, and no albumin or casts in the urine. A psoas abscess developed during the progress of the varicella. The ulcers on the face, as you see, have extended to such a degree that the child has lost the sight of one of its eyes. The child is sinking rapidly. The treatment, which has been essentially with stimulants, has failed to keep up its strength, and the local treatment in connection with the eye has proved entirely unsuccessful.

This child represents a case of gangrenous varicella.

Here is the temperature chart (Chart 13) of the case.

CHART 13.



Varicella gangrenosa.

(Subsequent history of the case.) The child continued to grow weaker, and died on the thirtieth day from the time when the first symptoms of the varicella were noticed. No autopsy was obtained.



**TREATMENT.**—The treatment of varicella is simply symptomatic. The child should stay in the house, and its room should be kept at an even temperature. The diet should be milk. The child should be carefully watched to prevent it from scratching, as lesions deep enough to produce scars may often be obviated in this way. This treatment should be continued until all the constitutional symptoms have passed away and the efflorescence has disappeared. Complete isolation should, if possible, be enforced, as, although the disease is usually insignificant, we can never in the beginning determine whether or not a rare and severe case is about to develop.

These rules for treatment are precautionary, and are based on the supposition that a child who has had a constitutional disease of this nature must be more sensitive to exposure of various kinds. As it is possible in some cases for the kidney to be affected in the later stages of the disease, just as it is in scarlet fever, it is well to guard against this complication by the protection of the skin from changes of temperature and by the use of milk as a diet. In a considerable number of cases, especially in young children, an anæmia of greater or less degree results from the disturbance of nutrition which so often accompanies the disease. In these cases the administration of saccharated carbonate of iron or of tartrate of iron and potash is indicated.

## LECTURE XXV.

## THE EXANTHEMATA.—(Continued.)

## SCARLET FEVER.

THE third member of the group of exanthemata which I shall speak of is scarlet fever, and I have brought you to the scarlet fever ward of the Boston City Hospital to-day to show you some illustrative cases of this disease.

Scarlet fever is an acute infectious disease, characterized by a short incubation, short prodromal stage, erythematous efflorescence, pronounced desquamation, and long course. The micro-organism which produces it has not yet been determined. With the exception of variola, it is the most dangerous of the group. As it occurs so much more frequently in early life than variola, on account of its not being preventable by inoculation, it is to the physician the most important of all the exanthemata.

The complications of scarlet fever are so much more serious and its sequelæ so much more common and grave than those of varicella and measles, that its immediate diagnosis and prompt treatment are of vital necessity in every community where numbers of children are liable to be attacked by the disease. It should, therefore, receive the most careful study of every physician whose practice is among children.

Scarlet fever is the most irregular of all the exanthemata in its virulence and in the manifestations which it presents in different individuals. It is usually epidemic, returning to the same localities after a period of years. It is at times sporadic, and is commonly endemic in large cities. That the epidemics of scarlet fever vary in severity has been clearly shown a number of times, so that we cannot ascribe the virulence of the disease in certain years to individual susceptibility. The sporadic cases may be of the most malignant or of the mildest type. A mild case may give rise to a malignant case in another child, and a malignant case may give rise to a mild one. The epidemics of scarlet fever spread slowly, in contradistinction to those of measles, which spread rapidly. Scarlet fever may occur more than once in the same individual, but this is rare. Instances have occurred where a child has had scarlet fever, and, on returning after several weeks to the same room, even after it had been disinfected, has again contracted the disease in its typical form. The source and identity of the contagium have not been definitely determined, but the skin appears to be its chief vehicle. This contagium has a wonderful tenacity for clothing and other articles, and may be capable of reproducing the disease for many months.

In reference to what I have just said concerning the slow spread of

scarlet fever during epidemics in comparison with the rapid spread of measles, certain clinical facts are significant. The disease does not seem to be very infectious in its early stages. We are thus led to believe that it is during the stage of desquamation that the contagium is most likely to be disseminated. Measles, on the other hand, is known to be highly infectious in its early stages, and for this reason to spread more quickly.

As the description of actual cases aids the student to remember important points in a disease, I shall in a few words tell you about two children who have been under my care, in order to show you the difference between scarlet fever and measles as regards the stage in which they are most likely to be infectious and the means by which their contagium is usually conveyed. Notice, however, that I say usually, for the contagium of both diseases may be active through their whole course.

A boy (Case 233) six years old and a girl (Case 234) four years old slept in the same room, with their beds touching each other. The boy was taken sick May 1, but remained in the same room with his sister during that day and the following night. He was seen by me early on the morning of May 3, and was then found to have scarlet fever. His sister was taken to the country, and the boy was left in charge of a trained nurse. There was absolutely no communication between the town-house and the country-house, either by people, clothes, or letter. I myself did not again see the boy during his sickness, having placed him under the charge of another physician.

On June 1 I was called to see the girl, and found that she had scarlet fever. There were no other cases of scarlet fever in the vicinity of the country-house where she had remained since leaving the city.

The boy at this time was desquamating freely, and four days previous to the girl's being taken sick a letter written by him had been sent to her, and she, after having had it read to her, had been allowed to keep it under her pillow.

A careful study of this case led to but one conclusion,—that the boy during the period of his desquamation had infected his sister at a distance of twenty miles by enclosing the contagium of scarlet fever in an envelope. The girl, although she had been in the same room with the boy for thirty-six hours at the beginning of the disease, and although susceptible to the disease, had not contracted it at that time, owing to its very slightly infectious nature in its early stages. On the other hand, the incubative stage of scarlet fever being only a few days, and many instances having proved that the disease is very infectious during its period of desquamation, it was evident that the girl had been infected by means of the letter.

In the following year, on May 20, I was again called to see the same boy. He had been well in the morning, but in the afternoon was found to have a high pulse and temperature, with coryza and lachrymation, so that it was deemed best to send the sister, who had been in the nursery only a few hours with her brother after he had been taken sick, to another house, while the boy was absolutely isolated. Three days later the boy was found to have measles. Ten days later the girl was attacked by measles. This case merely emphasizes the now commonly accepted belief that measles, in contradistinction to scarlet fever, is highly infectious in the early hours of the disease.

Whether the contagium of scarlet fever can be carried by the breath is, I think, somewhat doubtful.

There are, however, cases which lead me to believe that scarlet fever may be transmitted at a very early stage of the disease. An instance illustrative of this came to my notice not long ago :



A child (Case 235) who had contracted scarlet fever a few days previously came to a party given in a small and practically isolated community. At this time the child was beginning to feel sick and complained of a sore throat. A spoon which had been used by her was also used, before it was washed, by one of the other children. Six or seven days later this second child (Case 236) was attacked by scarlet fever.

A careful and critical investigation of the possible origin of the second case resulted in the evidence strongly pointing towards a direct transmission of the contagium from the mouth of one child to that of the other by the use of the spoon.

Scarlet fever may occur at all ages, but is rare during the first year of life. It has been met with in young infants who were nursing, and who have proved to be the focus of infection for a whole household.

It may occur in animals, and the infection may be transmitted by animals, such as dogs and cats, by milk, and by clothing.

There is no known prophylactic against scarlet fever except isolation, which for many reasons should be rigorously enforced. We must remember the fact that when the child has passed its tenth year the chances of its ever contracting the disease are very much lessened. We must also appreciate that it is especially important to protect children who are learning, or who have just learned, to talk. The commonly occurring and often intractable form of otitis which accompanies scarlet fever may not only render the child deaf, but in a case where the child has not learned to talk it may lead to deaf-mutism. We should, therefore, under all circumstances discountenance the opinion so often expressed by the laity, and sometimes even by physicians, that it is well for children to have these diseases while they are young, on the ground that otherwise they will probably contract them at a later period of life, when the type of the disease may be more severe. The assertion that the type of the disease is more severe in adults than in children is not corroborated by my experience.

**PATHOLOGY.**—The organs primarily affected in scarlet fever are the *skin* and the *throat*. The principal complications which arise in the course of the disease are connected with the *ear* and the *cervical glands*. The chief sequela, and the only one which is at all common, is *nephritis*. *Cardiac disease*, commonly secondary to the nephritis, may occur.

Lesions of the other organs are somewhat unusual and have no definite connection with the scarlet fever. They are generally due partly to the fever and partly to the septic processes which have arisen in the course of the disease, and are represented, as would naturally be expected, by a congested condition of the various internal organs, and by the usual changes which are found in pleuritis, pericarditis, endocarditis, and meningitis.

**Skin.**—Macroscopically the morbid conditions of the skin in scarlet fever, though varying in their manifestations, are usually represented by an intense general erythema covered thickly with minute macules, which are of a darker red than the accompanying hyperæmia. Minute white spots may also appear thickly scattered over the reddened surface, probably arising from areas of unaffected skin existing in the midst of the general hyperæmia. An appearance like that of milium is also at times noticed to be

scattered on the areas of skin affected by the erythema. No evidence of this hyperæmic condition, which is so pronounced during life, is found after death.

According to Neumann, microscopic examinations of the skin by means of hardened sections of specimens from cases of scarlet fever and measles in the stage of desquamation explain in a measure why the former is so much more likely to be infectious during its stage of desquamation than is the latter. In contradistinction to the pathological processes which are found in the skin in measles, and which affect chiefly the blood-vessels and glands, a very different picture is presented on examination of sections of skin taken from scarlet fever. In the latter we find the pathological process represented especially by exudative cells, which are very numerous and closely packed together, reaching even up to the horny layer of the epidermis. Occasionally these exudative cells may finally take the place of the epidermal cells, appearing on the free surface of the skin, and are gathered thickly among the excretory ducts of the cutaneous follicles. You will thus readily understand why the tissue proper of the skin and its epidermis present no marked changes in measles, and why the epidermal cells are far less likely to carry the contagium than in scarlet fever, where the possibility of contagium exists until the desquamation has entirely ceased.

**Throat.**—The earliest lesions of scarlet fever appear on the mucous membrane of the hard and the soft palate. This appearance is very similar to the efflorescence which is seen on the skin, except that the minute white spots do not appear on the congested mucous membrane. The pathological conditions which occur in the throat in scarlet fever may either be simply catarrhal, or result in one of the more severe inflammatory conditions affecting the tonsils, the pharynx, and the larynx.

As is stated by Delafield and Prudden, one of the most marked features of scarlet fever is the predisposition which it entails to the incursion of pathogenic germs other than those which we believe to cause this disease. Thus, in addition to the inflammatory lesions produced by the scarlet fever organism an acute exudative inflammation of the mucous membrane may occur, and may be associated with them. This is apparently caused by the growth of a streptococcus which, according to Welch, in morphological and biological character seems to be identical with the *streptococcus pyogenes*. In these cases there may be much or little fibrinous exudate, and there may in the early stages, or even through the whole course of the affection, be none at all. The pellicle when formed may be more or less adherent, and sharply circumscribed, or it may tend to spread. The submucous tissue may show little change, or much congestion and œdema, or it may be the seat of suppurative inflammation. The entire process may be confined to the tonsils. While under these varying conditions the inflammatory process is usually a local one and runs its course, with or without the symptoms of septicæmia, occasionally the streptococcus finds access to the blood and may induce the lesions of pyæmia. On the other hand, it may by inhalation



gain access to the lungs and induce varying phases of complicating bronchopneumonia. The staphylococcus pyogenes is not infrequently associated with the streptococcus in these lesions, but it is not apparently of prominent significance. Simulating very closely as it does in many cases both the local and the general phenomena of diphtheria, this pseudo-membranous condition was formerly confounded with it, but it is now recognized as a distinct disease.

There have been a number of extended investigations made on what are called the pseudo-membranous inflammations of the throat in scarlet fever. Booker has reported eleven cases of pseudo-membranous angina (two fatal) complicating scarlet fever, and one case of simple angina without exanthem in a family three members of which had scarlatina. In all these cases, as well as in four scarlatinal anginas without pseudo-membranes, Booker found streptococci as the predominant organism, and in none was the Klebs-Loeffler bacillus present. The staphylococcus aureus was found in eleven cases without apparent influence on the severity of the disease. No difference was observed between the early and the late pseudo-membranous anginas as regarded the bacteria present. Booker describes with much detail the morphological and bacteriological characteristics of the streptococci found, and divides them into groups.

Park, in a series of one hundred and fifty-nine cases, reports nineteen cases of pseudo-membranous inflammation of the throat complicating scarlet fever. In seventeen of these cases streptococci predominated, and in only two was the Klebs-Loeffler bacillus present. Staphylococci were found in only a few cases. Williams has also reported cases of this kind, and Morse has reported ninety-nine cases of pseudo-membranous inflammation of the throat complicating scarlet fever. The Klebs-Loeffler bacillus was found in twenty-three, with a mortality of forty-three per cent., and was not found in seventy-six, with a mortality of twenty-one per cent.

Finally, we may conclude that in scarlet fever the mucous membrane of the throat is rendered peculiarly vulnerable to the invasion of pathogenic germs. Where the morbid condition in the throat is represented by a pseudo-membrane it will be found that in the great majority of cases the process, as stated by Welch, is due to streptococci; but where diphtheria is prevalent and the opportunities are favorable for exposure, a large portion of the pseudo-membranous cases may be due to the Klebs-Loeffler bacillus.

In addition to the lesions of the throat just described, the micro-organism of scarlet fever may attack the naso-pharynx. In this way, also by direct extension through the Eustachian tubes, secondary aural lesions may be produced. The morbid changes in the mucous membrane of the naso-pharynx which thus take place may result in a thickening of the tissues, which in some cases lasts for many months after the scarlet fever has run its course.

**Ear.**—The pathological condition of the ear which is most commonly met with in scarlet fever is an acute inflammation of the middle ear. This



inflammation is likely to result in destruction of tissue, the formation of adhesions, the establishment of a long-continued suppurative process, and an accompanying necrosis.

**Cervical Glands.**—There may be hyperplasia of the cervical lymph nodes. This condition is sometimes accompanied by inflammatory œdema of the tissues of the neck, which may go on to suppuration and even to gangrene. In these cases streptococci are found in the glands and in the areas of suppuration. The infection is supposed to originate in the throat. The enlarged glands are, as a rule, indicative of secondary or mixed infection, though it is possible that the slighter forms of enlargement may be due to reflex irritation with resulting hyperplasia from the scarlet fever contagium. In the severe form the glands are at times very much enlarged, and where a gangrenous process results the blood-vessels may be affected to such an extent as to be ruptured.

**Kidney.**—In scarlet fever, as in a number of other infectious diseases, there are certain poisons produced in the course of the disease which are probably soluble in character. The results of bacteriological cultures in scarlet fever have shown that in a number of cases there is a general streptococcus infection, the infection probably coming from the lesions in the pharynx. In these cases of general infection streptococci may be cultivated from most of the organs of the body, there being a general septicæmia. In a number of these cases extensive lesions may be found in the kidneys, and yet these lesions may bear no relation whatever to the presence or absence of streptococci. In like manner, streptococci may be found in the kidney without any lesion of the kidney. These lesions are diffuse, and affect both kidneys and all parts of the kidney. From the best evidence which we have it would seem that the virus, or whatever it is which produces the lesions in the kidney, is not a living organism, but is a soluble chemical poison produced by the organisms of scarlet fever, or by other organisms, located in some other part of the body. This soluble poison when produced elsewhere is taken locally into the blood and affects various parts of the economy. In post-mortem examinations of scarlet fever certain lesions will be usually found in the kidneys.

These lesions, according to Councilman, may be divided into two classes, (1) represented by simple degeneration of the epithelium, and (2) represented by marked changes in the tissues of the kidney.

In the *first class* of cases the soluble poison may only affect the integrity of the capsular epithelial cells of the glomeruli. The poison may produce certain degenerative changes in these, but need not be accompanied by any proliferation of cells, or by any condition which would be characterized as inflammatory. It is more than probable that these simple degenerative lesions are accompanied during life by evidence of albuminuria, and in case death takes place there may be no macroscopic evidence of any lesions in the kidneys. Careful microscopic examination, however, will show a condition of degeneration in the capsular epithelium of the glomeruli.

Associated with this there will usually be found cloudy swelling of various degrees of intensity in the cells of the convoluted and the smaller collecting tubules. The degeneration here is rarely of a fatty character. Clinically, in the purely degenerative changes there may be only albuminuria with the presence of faint hyaline casts, and here and there a few leucocytes.

In the *second class*, owing to a greater intensity in the action of the poison, or to some possible difference in its character, more marked changes may take place in the kidney, and may be accompanied by the degenerative lesions which are distinctive of the first class. Different forms of lesions may occur in the second class, and, according to the predominance of one form over the other, may characterize a special form of renal disease. These lesions may be divided according to their anatomical distribution into *interstitial*, where there is a marked proliferation of the interstitial tissue of the kidney, and *glomerular*, where the lesions are chiefly confined to the glomerulus and its capsule.

In the *interstitial* form there will be found in the interstitial tissue between the tubules accumulations of cells, which are probably due to a proliferation of the cells of the capsule and of the connective tissue. These cells, or most of them, are epithelioid in character, and show very few leucocytes mingled with them. This form of nephritis should be considered as purely interstitial, since its lesions are in no way related to those of the epithelial tissue. There is both a general and a focal infiltration of cells in the interstitial tissue. The focal infiltration is found principally in the cortex of the kidney and about the glomeruli, the glomerulus frequently appearing as a centre from which the infiltration extends into the interstitial tissue between it and the surrounding tubules.

This form of nephritis was first described by Wagner as the lymphoid kidney. The kidney, macroscopically, is swollen; the capsule is easily stripped from the cortex, and is moist, whitish, and opaque. Usually there is no evidence of hemorrhage, although in some cases points of punctiform hemorrhage may be found in the cortex and in the intermediate zone.

Clinically, in this form there may be little evidence of the severity of the lesions. There may be, however, albuminuria corresponding to what is seen in the purely degenerative class. The quantity of the urine may be very little diminished, and casts may be present, as well as a certain number of desquamative epithelial cells and leucocytes.

These lesions are not confined to scarlet fever, but may be found in diphtheria, in measles, and in other infectious diseases of children, but they are not common in the infectious diseases of adults.

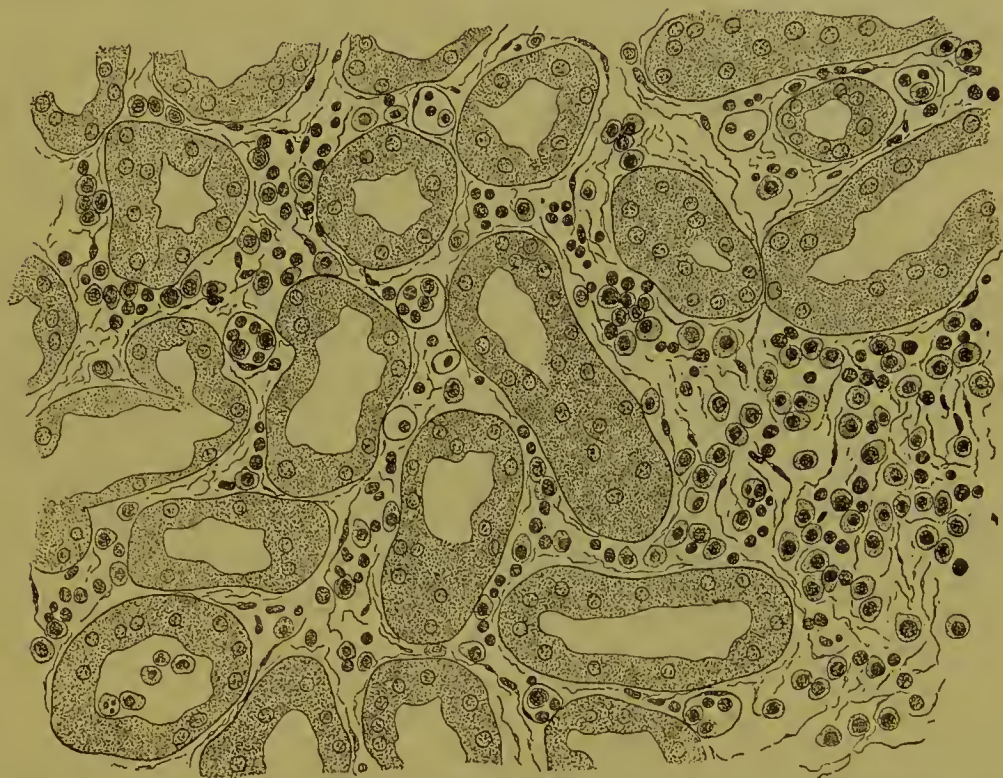
This microscopic section, made by Councilman (Fig. 90, page 539), represents a good example of these interstitial lesions in scarlatinal nephritis.

This section was taken from a case of pure scarlet fever. There was no anuria and no dropsy. The kidneys were enlarged, whitish, and without hemorrhage. Cultures from this case gave a general infection with streptococci in all the organs except the kidney, and I wish you to notice



especially that the kidneys, notwithstanding the extent of their lesions, were found to be free from streptococci. The epithelium of the tubules is somewhat swollen. The tubules themselves are slightly dilated, and the epithelium is more granular than normal. The interstitial tissue is much more extensive than normal. The spaces between the tubules are increased both by œdema and by cellular infiltration. In the interstitial tissue you will see blood-vessels filled with cells of the same character as those outside. It is probable that most of the cells outside come from proliferation of the cells of the blood-vessels. The round spaces in the interstitial tissue represent blood-vessels.

FIG. 90.



Interstitial nephritis. Section of kidney from child with scarlet fever. (Hartnack, ocular No. II., objective No. VIII. Tube closed.)

The other form of nephritis, called the *glomerular* (page 540), is much more frequently found in scarlet fever than the interstitial form, and may be considered as almost typical of the disease. In this glomerular form the chief lesion of the disease consists essentially in a proliferation of the capsular epithelium combined with hyperplasia of the connective tissue.

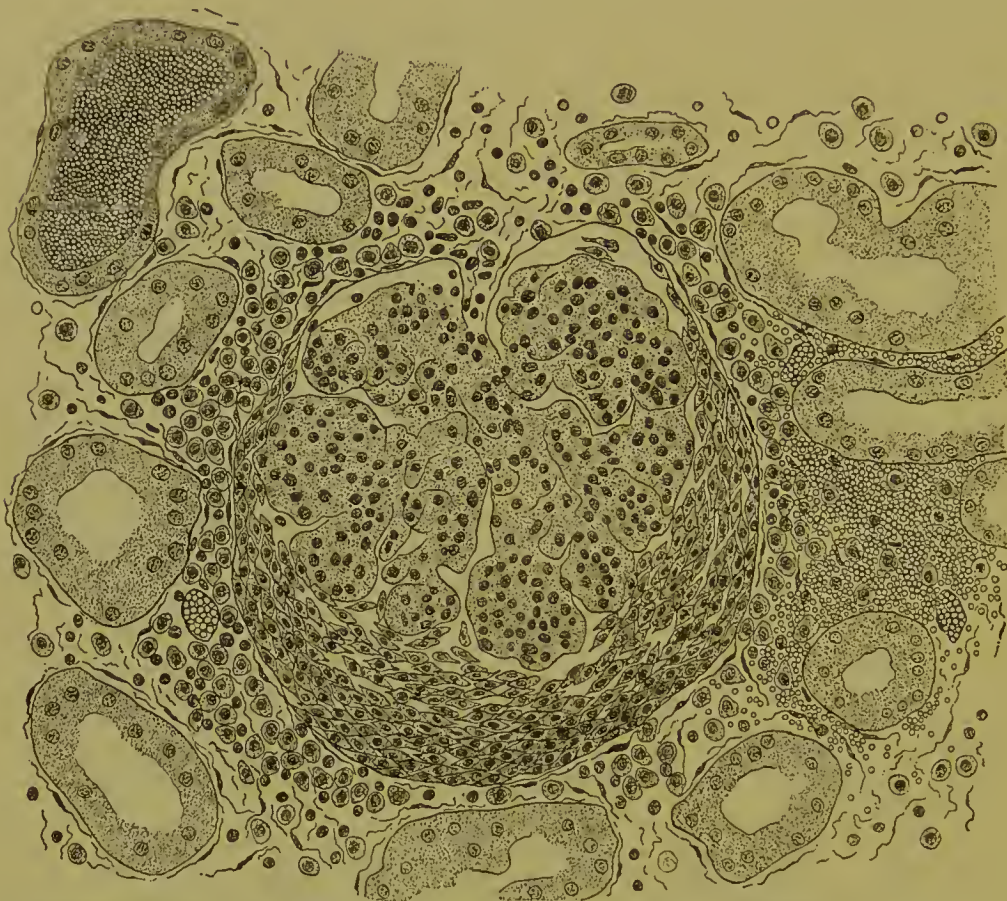
The proliferation of the capsular epithelium leads to the formation of masses of cells within the capsule between the glomerular capillaries and the capsule. These cells evidently result from the proliferation of the capsular epithelium. As a result of this there may be greatly increased pressure on the vessels of the glomerulus, with possibly obliteration of these vessels. The cellular infiltration in the interstitial tissue is not so extensive as in the other form (Fig. 90). Accompanying these changes in the glomerulus there is almost always more or less hemorrhage both in the tubules and in the interstitial tissue.



Here is a section, made by Councilman (Fig. 91), of glomerular nephritis.

This section was taken from a case of scarlet fever complicated by glomerulo-nephritis. In the centre of the field a glomerulus is seen, with an infiltration of cells in the capsular space. The capsular cells are oval and distinctly epithelioid in character. Cellular proliferation of the cells having

FIG. 91.



Capsular glomerulo-nephritis. Section of kidney from child with scarlet fever. (Hartnack, ocular No. II., objective No. VIII. Tube closed.)

generally the character of those in the section of interstitial nephritis (Fig. 90) is found, as you see, in the interstitial tissue. In the tubule at the left upper corner there is hemorrhage, and hemorrhage is found in the interstitial tissue on the right of the specimen. In this case the anuria and dropsy were extreme.

This form of nephritis may be best designated as *capsular glomerulo-nephritis*. The kidney is swollen and much more hyperæmic than in the interstitial form. The markings of the cortex either are obscured or cannot be made out at all, and there are numerous areas of hemorrhage and hyperæmia, giving the kidney a mottled appearance.

It is this capsular glomerulo-nephritis which gives the most marked clinical evidence of the extent of the lesions in the kidney. In this form dropsy is almost always present, the amount of urine is greatly diminished, and in the more severe cases there may be complete anuria. Blood-casts are found more frequently in the urine than in the interstitial form. The

diminution in the amount of the urine points to involvement of the glomerulus. Even severe cases of this form may be recovered from. The process of cell-proliferation may cease, the cells formed in the capsular space may disappear and pass out, and the kidney in after-years may show few or no evidences of the process through which it has passed. In a certain number of cases, however, from this form of nephritis a chronic nephritis is developed. Cases of this kind have been reported, notably one by Aufrecht.

In both the interstitial and the capsular glomerulo-nephritis fatty degeneration of the epithelium is not found to any degree. The epithelium is frequently swollen and granular, and may be hyaline.

These two forms of nephritis should be separated from each other, although transitions between their lesions are found. Usually they can be distinguished macroscopically.

We can, therefore, recognize three pathological conditions of the kidney in scarlet fever: first, the purely degenerative; second, the acute interstitial; and third, the capsular glomerular.

**Heart.**—The pathological conditions of the heart which are at times found in scarlet fever do not differ in their macroscopic appearances from those met with in other diseases. Cardiac disease occurring in the course of scarlet fever may arise in two ways: (1) from the general septic condition existing during the period of the height of the temperature and general efflorescence, and represented usually by an endocarditis; (2) at a much later period from a nephritis which has arisen as a complication, and following which, from the resulting increased blood-pressure, enlargement of the heart has been produced, which may be represented by hypertrophy or by dilatation, or by both.

In connection with this subject, Silbermann has found on examining a large number of cases of nephritis during attacks of scarlet fever a decided hypertrophy of the heart combined with dilatation. In some cases both sides of the heart were equally affected, but usually only the left side was involved. In only a few cases was there found a partial fatty degeneration of the muscular fibres; the endocardium, pericardium, and blood-vessels were normal. According to Silbermann's observations, the cardiac affection was related to the post-scarlatinal nephritis, and not to the scarlet fever process itself, as the hypertrophy was never found where the child died in the early weeks of the scarlet fever. He calls attention to the short period which intervened between the first appearance of the nephritis and the consecutive heart hypertrophy, in many cases the time not being much longer than a week. He also noticed that in the cases where hypertrophy and quick dilatation followed the acute nephritis of scarlet fever the ages of the children were three and a half, four, five, and six years, this post-scarlatinal cardiac enlargement thus corresponding to the physiological hypertrophy which I have referred to in an earlier lecture (Lecture IV., page 123).

Scarlet fever may be divided into (1) the benign form and (2) the malignant form.



I have already referred to the variations in type of cases of scarlet fever. The difference in the symptoms of the common, or benign, form of the disease from those of the rare, or malignant, form is very striking. They could well be classified as entirely separate diseases, were it not that the contagium has been proved to be the same in each, by the fact that one form of the disease may give rise to the other in different individuals. It seems as though it were more the susceptibility of the individual to the scarlet fever contagium than the contagium itself which produces a greater or less severity of the symptoms. I shall first speak of the benign class of cases, such as you see here in my scarlet fever ward, as it is this class which you will be more likely to meet with in your practice. These cases, as you will see, either run a simple typical course or are accompanied by variations and complications which make their course irregular. The simple typical case of the benign form of scarlet fever is such as I have already described, and is characterized by its sudden onset and long duration.

**INCUBATION.**—The stage of incubation of scarlet fever is uncertain and irregular, but, as a rule, it is shorter than that of any of the other exanthemata. It is usually less than seven days, and quite frequently it is only from two to four days.

**SYMPTOMS.—Prodromata.**—The invasion of the disease is usually sudden and, as a rule, active. The child feels very sick, looks dull, complains of sore throat and nausea, and in a large number of cases vomits continuously. The pulse is rapid. The temperature is high,— $39.4^{\circ}$ ,  $40^{\circ}$ ,  $40.5^{\circ}$  C. ( $103^{\circ}$ ,  $104^{\circ}$ ,  $105^{\circ}$  F.). In infants and very young children if the temperature rises to  $40^{\circ}$  or  $41.1^{\circ}$  C. ( $104^{\circ}$  or  $106^{\circ}$  F.) convulsions are very likely to occur. The higher the temperature at the beginning of the disease the more active the symptoms, and the shorter the prodromal period the more severe will be the case. An initial temperature of  $40^{\circ}$  C. ( $104^{\circ}$  F.) points towards a severe case.

Young children seem to show a less sensitive condition of the throat than is met with in older children and in adults. The appearance of the mucous membrane of the throat, although perhaps not characteristic, as at times a simple non-infectious pharyngitis may simulate it quite closely, is, in connection with the general symptoms, at least suggestive. The mucous membrane of the hard and the soft palate and of the pharynx is much congested. On the hard and the soft palate thickly scattered over the reddened surface are minute macules the color of which is a little darker red than that of the intervening mucous membrane. This condition represents the earliest stage of the efflorescence which later appears on the skin.

The length of the prodromal stage varies, as a rule, from twelve to thirty-six hours. During this stage the temperature continues to rise somewhat, and at its end the efflorescence appears on the skin.

**Efflorescence.**—The efflorescence of scarlet fever is of an erythematous and punctate character, sometimes looking as though minute macules had been sprinkled over the general redness of the skin. It starts on the front

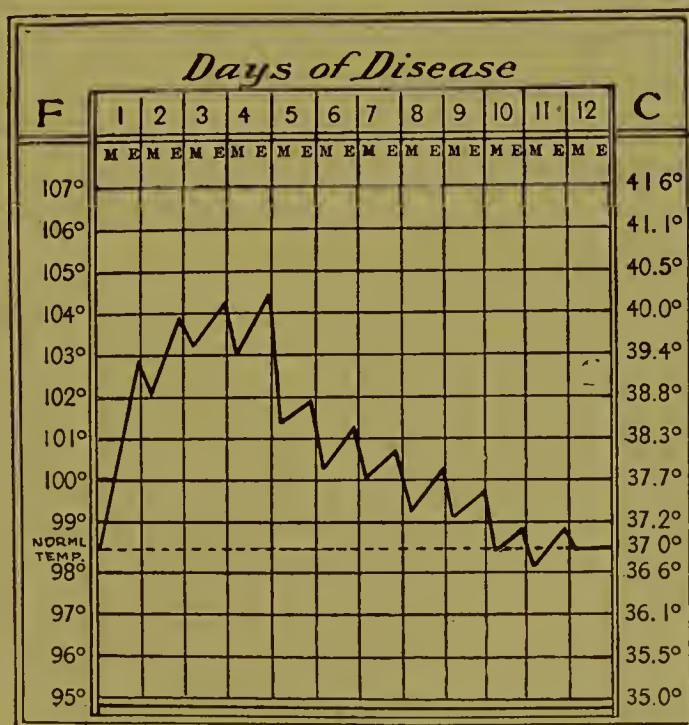


of the neck and the upper part of the chest, and rapidly extends all over the body and extremities, and upward to the face. This characteristic order of invasion of the skin aids us in distinguishing the efflorescence of scarlet fever from that of the common erythema which occurs in such diseases as pneumonia, and in cases where certain drugs, such as belladonna, have affected the skin and the efflorescence comes out everywhere at once and has an irregular distribution. It also enables us to distinguish the disease from measles, in which the efflorescence begins on the sides of the neck and on the face and extends downward. On gently drawing the finger over the efflorescence of scarlet fever the resulting white mark remains longer than is the case with a common erythema. The efflorescence of scarlet fever continues to extend over the body for two or three days after its first appearance. During this period the tongue is much reddened and its papillæ appear very prominent, constituting what has been called the "strawberry tongue." There is at times in this stage great irritation of the skin.

There may be slight delirium even in mild cases during the stage of efflorescence. This delirium may be very active and yet not be of serious import, provided the temperature remains moderate.

The temperature rises when the efflorescence appears, and reaches its maximum at the end of the outbreak, in uncomplicated cases, but there is no

CHART 14.



Benign and regular form of scarlet fever.

decided rise just before or fall after the height of the efflorescence, as is the case in measles; on the contrary, the temperature slowly diminishes until the ninth or tenth day from the beginning of the prodromal symptoms, when it becomes about normal, showing no decided crisis such as is seen in measles, but representing what is called lysis.

The pulse is quickened during the period when the temperature is elevated, and corresponds to it. It varies from 120 to 160.

This chart (Chart 14, page 543) represents the temperature as it commonly occurs in cases of scarlet fever of the benign and regular form.

The vomiting usually ceases in the stage of efflorescence, and often before the prodromal stage is ended.

**Desquamation.**—The stage of desquamation begins at about the seventh day from the time when the efflorescence first appears, and in the parts of the skin first attacked. The desquamation, however, is not always proportionate to the intensity of the efflorescence. This desquamation is at first composed of small particles of cutis, but these soon become larger, and early in the third week from the beginning of the disease they fall from the body in large flakes. This form of desquamation is called lamellar. Here again we have an important means of distinguishing scarlet fever from measles, for in measles the desquamation is almost universally of a furfuraceous character through the whole course of the disease, while the characteristic desquamation of scarlet fever is lamellar. This lamellar form of desquamation may at times, in certain individuals, and following the more intense inflammations of the skin, be represented by large and extensive pieces of skin. This is well shown in a specimen in the Warren Museum, where large strips of skin have come from the hand of a patient with scarlet fever so as almost to form a glove.

Sometimes the desquamation lasts only ten days, but it may continue for two or three weeks. It is especially slow in disappearing from the hands and feet, and it may remain between the fingers and toes for a number of weeks. Sometimes after the desquamation has apparently ceased and the skin has been smooth and normal for several days it may begin again, and thus prolong the period of convalescence.

**URINE.**—The *urine* is lessened in amount during the prodromal stage, returns to the normal amount in the stage of efflorescence, increases during the stage of desquamation, amounting at times to a polyuria, and returns again to the normal amount at the end of this stage. During the stage of efflorescence, especially if the temperature is considerably heightened, there may appear in the urine a small amount of albumin, but this disappears as the temperature subsides, is probably only the result of the fever, as in many other diseases accompanied by a high temperature, and is not to be confounded with the albuminuria of the nephritis which in some cases complicates the stage of desquamation.

There is considerable reason to suppose that a mild form of nephritis accompanies almost every case of scarlet fever, although in many cases no clinical symptoms pointing towards the kidney appear and nothing abnormal is found on examination of the urine. This statement, however, rests to such a degree on the authority of the general practitioner, rather than on that of the expert in urinary analysis, that we shall probably in the future find the number of cases which show nothing abnormal in the urine greatly



lessened when the number of expert examinations of the urine in mild cases of scarlet fever has increased.

PROGNOSIS.—The prognosis of the benign and regular form of scarlet fever is in almost every case favorable. It is comparatively rare for the symptoms to become sufficiently serious to cause death unless some complication has arisen in the course of the disease. The individual who succumbs to the simple uncomplicated form of scarlet fever, even when the initial temperature is high and the symptoms are severe, as a rule must have been unusually vulnerable to the toxic effects of the scarlet fever contagium, or must have had a very low degree of vitality at the beginning of the disease.

DIAGNOSIS.—The diagnosis of the benign and typical form of scarlet fever is not difficult. Its incubation is decidedly short in comparison with that of any of the other exanthemata. Its prodromal stage is short in comparison with that of variola and measles, and longer than the exceedingly brief prodromal stage of varicella. The characteristic prodromal symptoms of sore throat and a general and intense hyperæmia of the mucous membrane, accompanied by vomiting and severe constitutional symptoms, make it easy to differentiate it from measles, varicella, and variola, none of which, as a rule, show these symptoms.

The punctate erythematous lesions which appear in the stage of efflorescence of scarlet fever are rarely met with in any of the other diseases of this group. This efflorescence, beginning on the neck and chest and extending upward and downward, is distinguished by its peculiar distribution from that of the other members of the group.

The lamellar desquamation is very characteristic, and is seldom seen in any of the other exanthemata.

The complications arising in the ear, and the occurrence of nephritis as a common sequela in scarlet fever, do not to the same degree find their counterparts in varicella and measles.

TREATMENT.—As I have often told you in speaking of other diseases, so in scarlet fever, having an accurate knowledge of the chief pathological lesions which occur during the course of the disease, you can easily deduce the appropriate treatment. By treatment, you must understand, I do not mean simply the use of drugs. On the contrary, I would impress upon you that in my opinion drugs are employed to entirely too great an extent in a large proportion of the uncomplicated cases of the benign type of scarlet fever. I feel that I can speak with some authority on this point, as it has been my rule for many years to compare the results of cases treated by my colleagues with drugs with my own cases treated without drugs, and certainly nothing that I have observed in this comparison would indicate that my patients had suffered from want of treatment. We should have some definite reason for what we do, and should not be influenced by vague ideas of what drugs are supposed to be beneficial in certain diseases.

The treatment of a case of scarlet fever is that of a self-limited disease.



With our present knowledge of it, the disease cannot be cut short. We should, therefore, endeavor to keep it within its own limits by avoiding complications. To do this we must remember which tissues are affected as part of the disease and which are likely to be affected by complications.

In the first class, as I have already explained, we must consider the throat and the skin; in the second class the ear and the kidney. Remember, gentlemen, that I am now speaking of the mild cases of scarlet fever, and that the severe and complicated cases must receive their appropriate treatment as they arise.

The treatment here in my scarlet fever ward is rendered much easier than is the case in private houses by the fact that I am absolutely free from family prejudices as to how scarlet fever should be treated, and also because the patient can at once be put in a room from which all unnecessary paraphernalia have been removed. As, however, your cases in practice will be in their homes, it will be better for me to describe the general management and treatment of scarlet fever outside of hospitals.

At the onset of the disease the child, as a rule, is so profoundly affected by the scarlet fever contagium that it wishes to be put to bed at once. The symptoms which from their intensity require treatment in the prodromal stage of the disease are the vomiting, the sore throat, and the high temperature.

The vomiting, as a rule, is of such short duration, and is so symptomatic of nervous gastric disturbance caused by the toxic effect of the poison, that it should be looked upon as eliminative, and usually does not require the use of anything but pieces of cracked ice to be held in the mouth.

The treatment of the throat in scarlet fever is to be especially directed not only to allaying the temporary discomfort of the pharyngitis, but also to preventing the inflammatory process from extending through the Eustachian tubes to the membranæ tympani and producing an otitis which may result in a meningitis. This latter complication is rendered possible by the close vascular connection which exists in infancy and in childhood between the meningeal blood-vessels and the vessels of the tympanum through the open petro-squamosal suture.

Another reason for systematically treating the throat in all cases of scarlet fever is derived from the belief that the various secondary infections which take place in the disease are probably caused by the entrance of pathogenic organisms to the various tissues through the inflamed and vulnerable mucous membrane of the pharynx. This invasion is commonly of the cervical glands, the ear, the lung, the heart, and the kidney. If this belief is correct, antiseptic treatment directed to the throat is indicated as possibly preventive to the complications which may arise in the disease.

For the purpose not only of allaying the irritation of the throat, but also of preventing the spread of the morbid process to the ear, if possible, the throat and the nose may be sprayed several times during the day. Solutions of borate of sodium in water combined with a small amount of

glycerin are useful for this purpose. A four per cent. solution of boric acid in water can also be used to advantage. The local treatment, however, should always be of the mildest form, since any additional irritation of the mucous membrane will render it more vulnerable to the streptococcus invasion. If the child knows how to gargle, the discomfort which arises usually from the sore throat during the first day or two of the disease may often be allayed by simply gargling with cool water. This procedure answers a double purpose: it not only reduces somewhat the hyperæmic condition of the mucous membrane of the upper part of the throat and cleanses the anterior fauces, but also tends to prevent the extension of the pathogenic organisms which would necessarily be favored by a continuous recumbent position of the child. If the child is unable to gargle, some pieces of ice may be given to it to hold in its mouth, and it should occasionally be allowed to sit up, as when its nourishment is being given.

However desirable this treatment of the throat and nose may be in scarlet fever, we are but too often baffled in our attempts to treat them locally, on account of the persistent resistance of the child.

Chlorate of potash, which is so frequently used for the treatment of the throat in scarlet fever, is, in my opinion, a drug which in this disease it will be wiser not to allow the child to swallow, on account of its possible deleterious action on the kidney, which from the beginning of the disease to its end is in so sensitive a condition as to be readily affected by any irritant. Doubtless in a large number of cases we should not be likely to cause renal irritation by the small doses of chlorate of potash which are usually given. Children, however, differ very much in their individual susceptibility to drugs, and we can never tell beforehand whether or not a child is liable to be injured by them. We know that the vegetable salts of potash are decomposed in the system and eliminated as alkaline carbonates, thus causing no irritation in the kidney. Nitrate and chlorate of potash, on the other hand, which do not part with their oxygen in the system, are excreted undecomposed by the kidney, and thus act as irritants. Knowing that the tendency during the whole course of the disease is towards a renal hyperæmia, we should allow the child to have plenty of water to drink.

Unless the child shows decided signs of suffering from a heightened temperature, I do not use antipyretics in the form of drugs by the mouth, as the cases are rare where a temperature of  $38.8^{\circ}$  to  $39.4^{\circ}$  C. ( $102^{\circ}$  to  $103^{\circ}$  F.) for a few days will do harm. This is a safe rule to follow in a disease like scarlet fever, where, if the child happens to be easily affected by fever, the unfavorable symptoms will appear at once and can be attended to. My opinion is that mere heightening of the temperature without correspondingly severe symptoms causes much needless anxiety. In typical mild cases of the disease I should, knowing that a lessening of the amount of the urine in the prodromal stage as a result of the high temperature is a part of the regular course of the disease, discountenance the administration of diuretics



beyond a plentiful supply of pure drinking-water. The temperature, although it may cause severe initial symptoms, such as convulsions, as a rule, does not have to be directly treated during the prodromal stage. If, however, convulsions occur and continue and the temperature is unusually high, such as  $40.5^{\circ}$  or  $41.1^{\circ}$  C. ( $105^{\circ}$  or  $106^{\circ}$  F.), and if it remains at this height with serious general symptoms, such as delirium, you should endeavor to reduce it by sponging the body with water, the temperature of which should be varied according to the special case. To begin with, the temperature of the water should be about  $32.2^{\circ}$  C. ( $90^{\circ}$  F.).

I have mentioned before that scarlet fever is rare during the first year of life. There are certain observations which seem to show that nephritis is a rare accompaniment of scarlet fever during the first year. We know that milk is the food which is least irritating to the kidney. It would, therefore, seem but rational to make milk the diet in a disease which, like scarlet fever, points out to us by its pathology that we should as far as possible avoid irritating the kidney. It may be merely a coincidence, but it seems of some significance that the first year of life should also be the one which is least likely to present cases of scarlatinal nephritis. For this reason I am in the habit of putting my patients with scarlet fever absolutely on a diet of milk from the beginning to the end of the disease, or at least for four weeks. Perhaps in this way in a certain number of cases nephritis may be warded off, and if it develops, the patient is already on a diet which is best suited to the disease.

When the nausea and vomiting are present, the child, as a rule, feels too sick to take any nourishment whatever. When the violence of the toxic invasion has somewhat abated, and the diagnosis of scarlet fever has been made, orders should at once be given that the child is to have no food but milk. The treatment of scarlet fever with a diet purely of milk has in my practice proved so eminently satisfactory that it has become my routine treatment of the disease. During the initial stage of the disease, and until the stomach has recovered its equilibrium, lime water should be added to the milk in the proportion of one part to ten. Later the alkalinity of the milk can be lessened, and after the early days of the efflorescence the milk may in most cases be given undiluted. The administration of milk alone should be continued through the stages of efflorescence and desquamation, and until you are justified in supposing that a nephritis will not develop in the special case. This in general may be estimated at from four to five weeks from the time of the height of the efflorescence and temperature.

During the stage of efflorescence there are seldom any symptoms which require special treatment, in the regular form of the disease, except a considerable irritation of the skin which at times arises. This can be allayed by the application either of some simple ointment or of a powder of oxide of zinc and starch (Prescription 56). The use of the ointment is to be recommended not only because it keeps the skin soft and in good condition, but also because this application reduces the temperature somewhat. Sponging



the entire body with water at a temperature of 32.2° C. (90° F.), once or twice daily according to the comfort of the patient, is to be recommended.

During the stage of desquamation the application of a simple ointment to the whole body is desirable both for the purpose of softening the disintegrated epithelium and lessening the duration of this stage, and also to prevent the spread of the contagium by means of the loosened scales.

The child should be kept in bed until the desquamation has almost entirely ceased. This will cover a period of from four to five weeks. By the end of the fourth week, if the desquamation has completely disappeared, the diet can gradually be increased by the addition of soup and bread. It is well to keep the child in the house for five or six weeks, and still longer if the weather is cold or damp.

The *urine* should be frequently tested for albumin during the first three weeks, and afterwards when the child is first allowed to get up, after each change in diet, and after going out. If any albumin is detected, the child should be immediately put back to bed and on a diet of milk until the albumin has disappeared. Remember that the mild cases are the very ones in which a nephritis is liable to occur, and therefore we should watch them vigilantly until they are out of danger, which is usually in the fifth or sixth week.

**ISOLATION AND DISINFECTION.**—The disease being eminently infectious, the patient with its nurse should be isolated to as great a degree as circumstances will permit. An upper room should be chosen preferably. It has been observed in crowded parts of large cities that scarlet fever in tenement-houses is not so likely to spread when the first cases are in the top rooms of the tenements. In a number of instances in my practice I have had one child of a numerous family strictly isolated in the upper story of the house, and the other children have remained in the house without contracting the disease.

The intensity of the lesions of the skin and the involvement of large surfaces indicate that the air of the room should be kept at an equable temperature, in order that the function of the disabled skin should be taxed as little as possible and that the internal organs should not have too great compensatory work forced upon them. The temperature should be kept at about 20° C. (68° F.).

A disease which renders necessary confinement to the room for weeks demands a room with good ventilation and plentiful sunlight. Therefore a room on the sunny side of the house, having an open fireplace, should be chosen.

The room should be free from all cotton or woollen materials except such as can be destroyed by fire at the end of the disease. The blankets, sheets, towels, and clothes can, of course, be disinfected, but it will save much ultimate trouble to remove the carpet and the curtains and replace them with pieces of old carpet and sheets. The pictures, and in fact everything worth preserving, had better be removed. The room can be made

cheerful enough by means of cheap colored prints and destructible toys to amuse the child.

During the whole course of the disease the greatest care must be taken to disinfect the linen of both the patient and the nurse. This should be done by soaking it for twenty-four hours in a five per cent. solution of carbolic acid, then boiling it for half an hour in water, and finally washing it with soft soap solution, 20 grammes ( $\frac{2}{3}$  ounce) to 10 litres ( $10\frac{1}{2}$  quarts) of water.

The dejections are to be received in a vessel one-quarter full of a five per cent. solution of carbolic acid.

After the child is entirely well it is to be thoroughly washed first in a solution of corrosive sublimate 1-2000, and then immediately with water, so as to avoid irritation of the skin. The child is then to be taken to another room to be wiped and put into fresh clothes, which, of course, have not been in the scarlet fever room. The mattress is to be tied up in canvas wet with a corrosive sublimate solution 1-500, and sent out of the house to be disinfected, if possible by steam. I usually advise the family never to have it brought back again. In place of the mattress it is far better to use old blankets, which, if in sufficient number, are comfortable, and at the end of the sickness can be thoroughly boiled and thus disinfected. The useless articles which have been in the room during the sickness should be burned in the open fireplace.

The room must next be disinfected. This is a very difficult matter to do absolutely, but there are several methods which are far better than the usually recommended disinfection by sulphur which has been so generally used for this purpose during the past century. I mention sulphur as a disinfectant merely to tell you that it was proved by Koch as long ago as 1881 to be entirely unreliable.

If there is paper on the walls, it should be scraped off and immediately burned. The floor should then be washed with a solution of corrosive sublimate 1-500, followed by soap water. The ceilings, the walls, all the woodwork, and the furniture are to be thoroughly rubbed with bread and then wiped with the corrosive sublimate solution 1-500. Esmarch has shown that bread is the best means for removing infectious material from surfaces of this kind. The micro-organisms adhere with great tenacity to the bread, which, with any crumbs that break off and fall to the floor, must be carefully collected and destroyed by fire. The room should then be aired for several days. I always advise the family, if there are other children in the house, to have the whole room, including the ceiling and the floor, painted.

You must also bear in mind that you, by means of your hair, beard, and clothes, are the possible means of transmitting the contagium from one patient to another, and that it is your manifest duty to the public to change your clothing and disinfect yourselves on leaving a scarlet fever patient.

This case (Case 237), the notes of which I find in my records, will, I

PLATE VII.



Scarlet Fever



Measles





think, serve to show you the characteristics of the benign type of scarlet fever without variation from the regular type and without complications :

A boy four and one-half years old was noticed by me on November 6, when I was vaccinating his sister, an infant, to be quite sick. Besides the infant the boy's two brothers, one two and a half years old and the other six, were in the room with him. The mother supposed that the boy had an attack of indigestion. He had been vomiting quite frequently and had no appetite. His pulse was 120. His temperature was  $38.3^{\circ}\text{C}$ . ( $101^{\circ}\text{F}$ ). He had no headache and no sore throat, but he had the appearance somewhat characteristic of scarlet fever well marked on the hard and the soft palate. He was placed in an upper room of the house and completely isolated with a trained nurse. The vomiting continued until evening, when it stopped and did not return.

On November 7 he was reported to have had a restless night. His throat was found to be very much reddened and to feel a little sore. His pulse was 135. His temperature was  $38.3^{\circ}\text{C}$ . ( $101^{\circ}\text{F}$ ). He had had a natural movement of the bowels. His appetite was poor.

All unnecessary articles were immediately removed from the room, and he was confined to his bed. He was placed on a diet of milk and given as much water as he wished to drink. The efflorescence of scarlet fever very soon appeared on his chest.

On November 8 the efflorescence had spread all over his body. He was reported to have slept well and to have vomited his milk but once. His pulse was 125, and his temperature was  $37.7^{\circ}\text{C}$ . ( $100^{\circ}\text{F}$ ). He was sponged twice daily with water at a temperature of  $32.2^{\circ}\text{C}$ . ( $90^{\circ}\text{F}$ ), and as the skin was somewhat irritable the itching was allayed withunctions of vaseline. The temperature of the room was kept at  $20^{\circ}\text{C}$ . ( $68^{\circ}\text{F}$ ).

On November 9 the efflorescence had spread to the limbs, and was also present to a slight degree on the face. At 6 A.M. the pulse was 120, the temperature  $36.6^{\circ}\text{C}$ . ( $98^{\circ}\text{F}$ ). At 6 P.M. the temperature was  $37.2^{\circ}\text{C}$ . ( $99^{\circ}\text{F}$ ), and the pulse was 120. He had a little more appetite, his skin was less reddened, and his throat was not so sore.

On November 11 the efflorescence began to fade, first on the chest. On November 13 the temperature became normal, and desquamation began, first on the chest. On November 25 the desquamation had almost ceased, and the boy was allowed to get up and play about the room for an hour. On December 1, the desquamation having almost ceased for several days, he began to desquamate freely again. On December 8 the desquamation ceased. He was disinfected and then sent down-stairs among the rest of the children. He went out of doors December 25.

No albumin was detected in his urine during the whole course of the disease. He resumed his usual diet on December 10.

None of the other children contracted the disease, although they remained in the house while their brother was sick.

I shall now show you in this bed a typical case of the benign form of scarlet fever with the distinctive efflorescence of the disease on the chest, neck, and face.

The boy (Case 238, Plate VII., Scarlet Fever) is ten years old. He is said to have been exposed to scarlet fever eight days ago. He was taken sick, with sore throat, vomiting, a quickened pulse, and heightened temperature, four days ago. Three days later this efflorescence appeared, first on his neck and chest, and later it spread downward over the trunk and extremities and upward to the face. The efflorescence is, as you see, in the form of a punctate erythema. You will notice that the degree of redness is much changed according as the skin is protected by the warmth of the bedclothes or is exposed for a greater or less time to the temperature of the room.

There is, therefore, no definite color or degree of red color which is characteristic of scarlet fever, as it is liable to vary from many causes. The vomiting ceased three days ago. The boy has been at times slightly delirious for the past two days, but to-day the tempera-

ture, which for the previous three days has risen to from 40° to 40.5° C. (104° to 105° F.), is beginning to fall, corresponding to the maximum of the efflorescence having been passed. His mind is now perfectly clear.

There has been until to-day a trace of albumin in his urine, but no casts have been detected, and it has been only slightly lessened in quantity.

He has no complications. Although he looks quite sick, he represents merely a pronounced and typical example of the benign and regular form of scarlet fever. On entering the hospital he was placed at once on a diet of milk. He takes and digests the milk well, and, unless some complication arises, he shall have no medicine given him, nor shall he have any food but milk for at least four weeks.

**VARIATIONS IN THE BENIGN FORM.**—In the benign form of scarlet fever we may have great variations from the typical manifestations of the disease which I have just described to you.

A heightened temperature in the evening sometimes continues for over a week after the efflorescence has faded, without the existence of any ascertainable cause: this occurrence should always be looked upon with suspicion. After a rapid increase of temperature at the beginning of the disease there sometimes ensues a condition of complete apyrexia, while all the other symptoms continue to develop in the usual manner. When the temperature remains heightened at the end of the period of efflorescence and continues into the period of desquamation, especially when there is no local pain anywhere, we should suspect that a nephritis may be developing. When the temperature after having become normal rises again, we should suspect such complications as otitis and suppuration of the subcutaneous tissues of the neck, or that the heart is involved.

Relapses may take place in scarlet fever. In some of these cases after the efflorescence has disappeared it may return in the second or third week, during the stage of desquamation, and even after the desquamation has ended. The symptoms of these cases are sometimes more severe than those in the first attack, but in most of the reported cases of relapse in scarlet fever the first attack has been a mild one. Such cases occur usually in older children rather than in younger, and must be sharply distinguished from the cases where a fresh infection has taken place and which are characterized as a second attack of the disease. Thomas reports a case of scarlet fever complicated by varicella, in which on the twenty-fifth day of the scarlet fever a relapse occurred, and on the twenty-sixth day a second attack of varicella developed.

Certain cases of scarlet fever have been reported in which in the latter part of the disease, and after the temperature had become normal, the temperature rose to 40°–41.1° C. (104°–106° F.), where no cause could be discovered for the hyperpyrexia, and where the patients recovered after being promptly treated with cold baths to reduce the temperature.

Scarlet fever may begin with such great cerebral excitement as to lead us to suspect meningitis, and it may not be possible to determine the diagnosis until the efflorescence has appeared, which may not be until even the eighth or ninth day.



The efflorescence may last only twenty-four hours, or it may last fourteen days. We must remember that we are not to depend upon the efflorescence in making our diagnosis in scarlet fever, as it may be so evanescent as to be scarcely recognizable.

Convulsions occurring at the onset of the disease are not, as a rule, indicative of a fatal issue, but when they occur later they are usually of serious import.

The occurrence of scarlet fever in surgical cases is of no special significance beyond the apparently greater susceptibility of patients with open wounds to contract the disease. We should bear in mind the suggestion of Osler, that in the majority of these surgical cases thus far recorded the efflorescence has probably been the red rash of septicæmia, and that the reported cases have become rare since the gradual disappearance of septicæmia as a complication of surgical operations. Atkinson also suggests that in many cases these rashes may have been due to the quinine which was given to the patient.

A variation may arise from the ordinary scarlatinal inflammation of the mucous membrane of the throat becoming more severe than usual and resulting in exudation. The larynx in some cases may also present unusual symptoms, such as aphonia, and serious symptoms caused by a concurrent oedematous condition of the glottis may arise and even produce a fatal issue.

I have in this next bed a case which represents certain variations from the typical symptoms which occur in the throat and nose, and which are very mild in their character :

This boy (Case 239), three years old, was attacked four days ago. The invasion of the disease was characterized by drowsiness, loss of appetite, malaise, slight nausea, a quickened pulse, a temperature of  $39.1^{\circ}$  C. ( $102.5^{\circ}$  F.), and intense sore throat.

On the second day of the disease the temperature continued to rise, and in the latter part of the day a punctiform erythema appeared on the neck, and later on the face and hands. During the next night he was very restless, sleeping only five or ten minutes at a time, and complaining of his throat, of headache, and of being very thirsty. His breathing was rather rapid. On the morning of the third day the record showed that in the past twenty-four hours he had taken only 120 c.c. (4 ounces) of milk ; he had had no movement of the bowels and had passed 300 c.c. (10 ounces) of urine. His pulse was 134, his temperature  $39.4^{\circ}$  C. ( $103^{\circ}$  F.), and his respirations 34. In the evening the pulse was 134, temperature  $39.6^{\circ}$  C. ( $103.5^{\circ}$  F.), and respirations 30. His throat continued to be painful. The whole throat was reddened, and the tonsils were enlarged. There was a thick muco-purulent discharge from the nose. The glands of the neck on each side were enlarged. There was considerable irritation of the skin during the day, which was relieved by the occasional use of a lotion containing carbolic acid 4 c.c. (1 drachm) to water 473 c.c. (1 pint).

This morning he was reported to have had a very restless night, to have taken 420 c.c. (14 ounces) of milk in the twenty-four hours, to have had one movement of the bowels, and to have passed 600 c.c. (20 ounces) of urine in the twenty-four hours ; the temperature was  $38.6^{\circ}$  C. ( $101.5^{\circ}$  F.), pulse 128, and respirations 28. The child is very irritable and restless. You see that there is a constant copious muco-purulent discharge from the nose, and that he coughs quite frequently. The glands on each side of the neck are still considerably swollen. The scarlatinal efflorescence has invaded the entire body, has extended over the limbs, and is accompanied by considerable irritation. On examining the throat you will see that its entire mucous membrane is very much reddened and that the tonsils are swollen.

On both tonsils, especially on the left, are some small yellowish-white spots apparently connected with the crypts. In one place these spots have coalesced. There is also considerable exudation, though apparently not of a membranous character, in the pharynx. I shall have a bacteriological examination made from the exudation in various parts of the throat. Material for this examination can be procured by means of a sterilized platinum wire, which you see can be easily used, as the child does not object to opening his mouth and allowing me to use the wire.

(Subsequent history of the case.) On the evening of the fourth day the temperature rose to 39.6° C. (103.5° F.), the pulse was 124, and the respirations were 28.

On the fifth day the report was that during the previous twenty-four hours the child had taken 540 c.c. (18 ounces) of milk and had passed 660 c.c. (22 ounces) of urine. He had slept better, but, owing to the extreme restlessness, he had been given 0.6 gramme (10 grains) of bromide of soda during the night. The efflorescence was beginning to fade. The throat was not so sore, and there was no appearance of any newly-developed morbid conditions in it.

On the sixth day of the disease the temperature in the morning was 37.7° C. (100° F.) and in the evening 39.6° C. (101.3° F.); 300 c.c. (10 ounces) of milk had been taken in the previous twenty-four hours and 915 c.c. (30½ ounces) of urine had been passed. There was decided improvement in the throat and nose.

The bacteriological report stated that in the culture made from the exudation which had been taken from the throat the Klebs-Loeffler bacillus could not be found.

On the seventh day of the disease the temperature in the morning was 37.4° C. (99.4° F.) and in the evening 38.5° C. (101.5° F.). Although the appearance of the throat had improved, the patient was very fretful, and the voice was quite hoarse.

On the eighth day the child had become much more hoarse, and was unable to speak except in a whisper. The discharge from the nose had ceased. The temperature in the morning was 37.4° C. (99.5° F.) and in the evening 38.2° C. (100.8° F.).

On the following day, the ninth from the invasion of the disease, the child was much brighter; his appetite returned, so that he took 1200 c.c. (40 ounces) of milk in the twenty-four hours, and he passed 840 c.c. (28 ounces) of urine. The swelling of the glands in the neck had almost disappeared, and the throat showed no evidence of irritation.

From this time the temperature continued to vary from 37.5° C. (99.5° F.) in the morning to 37.7° C. (100° F.) in the evening until the thirteenth day, when it became normal. Desquamation began on the eighth day and continued until the twentieth day. No other symptoms arose, and there was no disturbance in connection with the kidney. He recovered his voice on the nineteenth day.

In the benign form of scarlet fever certain cases are at times met with in which the high temperature, or the especial vulnerability of the child to the scarlet fever contagium, causes the symptoms to vary considerably from the typical form and to be unusually grave. As an instance of this class of cases I will report to you one which was seen by me in consultation with Dr. Robert P. Loring, of Newton Centre.

The child (Case 240) was a girl, six years old. The point of variation from the typical cases of scarlet fever was in this case an unusually high temperature. The invasion of the disease was characterized by restlessness and sore throat, which were soon followed by vomiting and delirium. The temperature on the first day rose to 41.1° C. (106° F.). The highest temperature was on the second and third days, when it reached 41.6° C. (107° F.). During the first three days the pulse could not be counted. The high temperature continued until the sixth day from the beginning of the prodromal symptoms. There was great gastro-enteric disturbance, and during the first forty-eight hours there was almost continuous vomiting. This was succeeded on the third day by frequent profuse, and often involuntary, serous discharges from the bowels. These discharges continued until the fifth day. On the fourth day a slight erythematous efflorescence appeared on the neck and chest, and on the



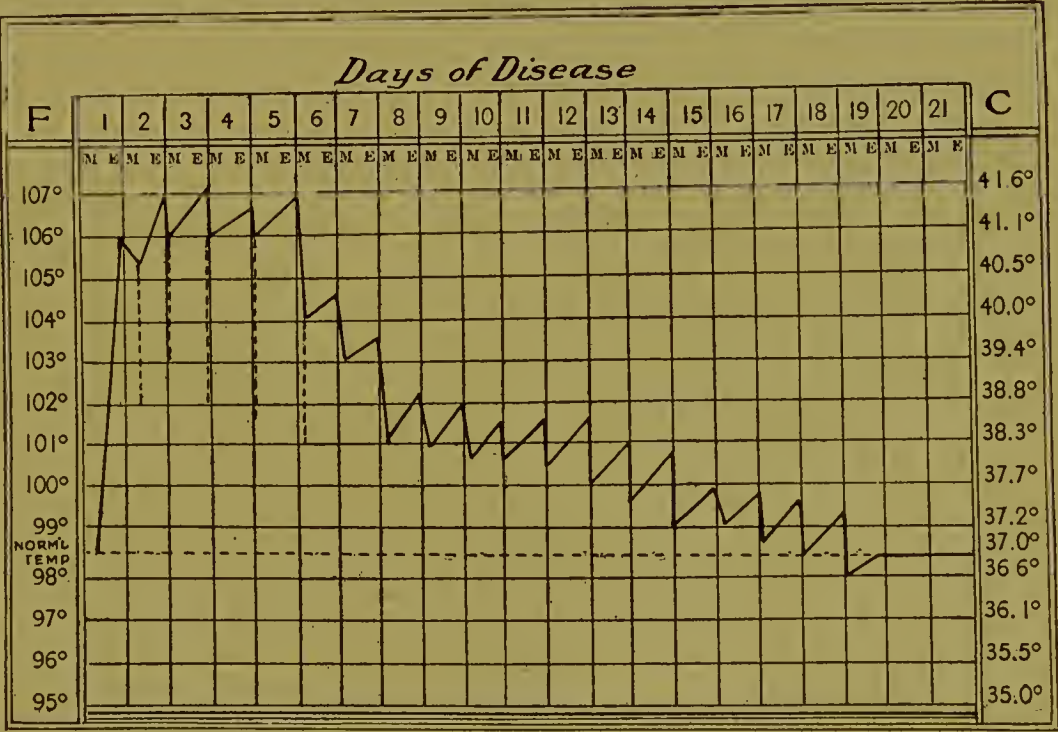
fifth day it extended all over the body and was of an intense character. On the sixth day a complication of pain in the wrists began, but it disappeared in twenty-four hours under the administration of salicylic acid. At this time also there was considerable swelling on the left side of the neck, which gradually disappeared in four or five days. When the fever was at its height there was considerable cyanosis, with quickened respiration. The pulse at this time was weak and difficult to count. From time to time during the attack tincture of digitalis was given for the restlessness, and bromide of soda was occasionally used. Tincture of digitalis was given when the pulse was quick and weak and cyanosis was present, but the treatment which was most depended upon was by bathing.

The method of bathing for the purpose of reducing the temperature was that of placing the child in a tub of water. Whenever the temperature reached 40.5° C. (105° F.) the child was placed on a pillow in the bath, and was kept there until the temperature was reduced three or four degrees. The time required to accomplish this was usually from one to one and a half hours. While the child was in the bath stimulants and milk were given to it. The temperature of the water was about that of the child, and was gradually reduced to about 32.4° C. (90.5° F.). During the first four days the child was either delirious or in a comatose condition, and when in the bath would pass its urine and faecal discharges involuntarily.

The high temperature continued until the sixth day from the beginning of the prodromal symptoms, when it fell decidedly, from which time the baths were omitted, and the temperature continued to fall by lysis until it reached the normal degree on the sixteenth day from the invasion of the disease. After this the child had no unusual symptoms, and made a rapid recovery. There were no complications. The desquamation took the usual course.

Here is the chart (Chart 15) of this case. The broken lines show the degree to which the temperature was reduced by the baths.

CHART 15.



Toxic symptoms and high temperature in scarlet fever treated by baths.

COMPLICATIONS AND THEIR TREATMENT.—Most of the complications which arise in scarlet fever are due probably to the action of streptococci, either isolated or associated with other micro-organisms. These micro-organisms produce serious symptoms, which are often followed by death,



either directly by giving rise to septicæmic processes or indirectly by nephritis.

It is supposed that the infection which complicates scarlet fever enters the system commonly through the pharynx either by direct absorption or by inhalation of these organisms.

**Throat.**—In addition to the milder forms of inflammation in the throat which occur in the course of scarlet fever, this simple inflammation may be complicated by more severe lesions. In these cases there may be an exudation affecting the mucous membrane of the entire buccal cavity and throat, evidently produced by streptococci. This complication adds greatly to the severity of the scarlet fever, and is a common source of invasion of the ear and of infection of the cervical glands. In addition to lesions of this class you will at times meet with a membranous condition of the mucous membrane of the throat, the pathological lesions of which cannot be differentiated from those of diphtheria. This membranous condition is caused by the action of streptococci, and the diagnosis between these membranes and those which are produced by the Klebs-Loeffler bacillus cannot be made except by means of bacteriological examination. These more severe inflammatory conditions of the throat are not common in my experience outside of hospitals, but have been observed a number of times in our scarlet fever and diphtheria wards at the City Hospital. In these cases of streptococcus invasion the entire throat may be very much swollen, the tonsils enlarged, and the naso-pharynx affected to such a degree as almost to occlude the nares. It is necessary to make a bacteriological examination of these lesions which have been called pseudo-membranes, if we wish to determine in the early days of the disease whether or not we are dealing with a case of diphtheria. After the first three or four days in most cases there is usually so marked a clinical difference between the progress of the disease where the Klebs-Loeffler bacillus is present and that where the exudation is simply secondary to a streptococcus invasion, that we are not long in doubt as to our diagnosis, even without the decisive proof by culture. As a rule, where the Klebs-Loeffler bacillus is present the continued increase in the severity of the symptoms and the resulting exhaustion of the child show us that we are dealing with this micro-organism. We must not, however, be misled by this general rule of differential diagnosis, for there are many cases in which it is impossible to differentiate between a streptococcus invasion and an invasion of the Klebs-Loeffler bacillus either by the appearance of the throat or by the clinical symptoms. On the one hand, the streptococcus invasion may be quite as severe in its symptoms as that of the Klebs-Loeffler bacillus, while, on the other hand, true diphtheria may occur where the symptoms are as mild as any that are produced by the other micro-organisms.

The treatment of the throat in these severe secondary conditions is the same as I have already spoken of in the treatment of the benign forms, except that, if possible, it should be carried out more rigorously. As the disease

runs a comparatively short course, there is not such a need for stimulants as is indicated where diphtheria is present. In young children it is often impossible to treat the throat locally, and I have usually found that my chief reliance in tiding over the severe stage of the disease is the administration of sufficient food, and of stimulants when they are indicated by the general condition of the child. It is to be remembered, of course, that the throat in scarlet fever may be attacked by the Klebs-Loeffler bacillus and the disease brought to a fatal issue by a complicating diphtheria. When diphtheria is present, the treatment should be the same as for a primary case of diphtheria; and this I shall refer to in a later lecture (Lecture XLII., page 828).

In the more severe forms of inflammation in the throat the inflammatory process may go on to abscess, as in the pharynx, but the most common place is in the tonsil or in its neighborhood. These abscesses must be carefully watched for, and when detected opened with antiseptic precautions as soon as possible. We shall by this treatment often shorten the course of the disease, and thus save loss of strength and vitality on the part of the patient.

As an example of one of the more severe lesions occurring as a complication in the throat in scarlet fever, I shall report to you a case which occurred in my practice.

A boy (Case 241), two and a half years old, was seized on December 4 with diarrhœa, vomiting, and sore throat. On December 5 the tonsils were found to be enlarged and the whole throat much reddened. The efflorescence of scarlet fever appeared on the chest, and the child seemed dull and sick. The temperature was 40° C. (104° F.) and the pulse 150.

On December 6 both sides of the neck were much swollen, and the tonsils were much enlarged.

On December 7 there was considerable muco-purulent discharge from the nose, and the temperature was 39.7° C. (103.5° F.). The child was not so dull, and the efflorescence was well marked over the whole body.

On December 8 the diarrhœa continued, and the temperature and pulse remained about the same. The child took milk regularly, but refused to have any applications made to its throat or nose.

On December 10 there was no especial change in the general symptoms, except that the diarrhœa was less and the throat and nose were rather sore. There was a peculiar grayish-white exudation around the mouth and throat which could be easily removed. The neck on both sides was swollen and hard. The pulse was rather weak, 140, and stimulants were given every two hours.

On December 11 there were less hardness and swelling of the neck, and less discharge from the nose, the pulse was 150, the temperature was 39.4° C. (103° F.), and the efflorescence was fading.

On December 12 there was much exudation from the mouth, but the child took more milk, and desquamation had begun.

On December 13 the temperature was 38.8° C. (102° F.) and the pulse 150. The child cried a great deal, was very restless, and complained of pain in the joints, but the neck was less swollen.

On December 14 the child vomited twice during the night. On December 15 the pulse was 135 and the temperature 38.3° C. (101° F.). On December 18 the temperature was 37.7° C. (100° F.), and there was a profuse flow of saliva: the breathing sounded as though the throat and posterior nares were considerably occluded.

On December 20 the pulse, which had been decidedly weak, became stronger; its rate



was about 150, and the temperature was 37.2° C. (99° F.). The child seemed much brighter, and the throat was less troublesome. The pains in the legs, however, were quite severe.

On December 21 the pulse was 148 and the temperature 36.6° C. (98° F.). There was considerable discharge from the nose, and there was an efflorescence of herpes on the lips and face.

On December 23 both tonsils were found to be much enlarged and of a deep red color. The temperature from this time remained normal, and the child rapidly improved until December 28, when it complained of pain in the left ear: some hours later, perforation of the membrana tympani took place and there was a slight muco-purulent discharge.

On December 29 both ears were gently irrigated with lukewarm water. Up to this time the urine had shown no abnormal condition, but on this day it was found to contain a faint trace of albumin, and the specific gravity was 1013.5. The sediment was small, and consisted of small round renal epithelium, mucous casts, and an occasional hyaline cast, representing a condition of hyperæmia. From this time the child rapidly recovered, the temperature remained normal, the swelling and hardness of the neck entirely disappeared, the albumin and casts disappeared from the urine, and the ears recovered without resulting deafness, but for over a year there was evidence of decided thickening of the tissues of the naso-pharynx. There was no subsequent paralysis.

In this case the child resisted all attempts at treatment so strenuously that little was done beyond the administration of milk and brandy. A bacteriological examination of the exudate in the throat was not obtained, so that the Klebs-Loeffler bacillus could not be definitely excluded as a cause, but the subsequent course of the disease showed that in all probability diphtheria had not been present. It therefore represents very well the typical course, uninfluenced by drugs and special treatment, of one of the more severe forms of scarlet fever with a complication in the throat.

**Cervical Glands.**—The glands of the neck are more or less enlarged, according to the severity of the infection. This enlargement may in some cases be so great as to cause much swelling and distortion of the face and neck. The swelling extends at times under the chin from one ear to the other as a mass of cellulitis. The tissues of the neck under these conditions may, as I have already described to you in speaking of the pathology of the disease, suppurate, and this condition, even if it does not produce a fatal result from gangrene, may greatly prolong the period of convalescence.

While the glands are enlarged and tender, the application of hot fomentations usually gives much relief, as does also in some cases an ice poultice. Beyond this I am not in the habit of making any external application.

**Ear.**—The middle ear is so closely connected by means of the Eustachian tubes with the naso-pharynx that aural complications are exceedingly common where naso-pharyngeal irritation exists. I shall, therefore, next speak of the complications which arise in the ear during the course of scarlet fever.

The symptoms which indicate that a secondary infection of the ear is taking place are not always clear, as they may differ much in their manifestations. We should therefore watch with the greatest solicitude and examine with the greatest care the ear during the course of scarlet fever. The symptoms may be active and represented by aural pain and great restlessness. On the other hand, there may be no apparent pain, especially in infants and young children, who are often unable to indicate the location of the pains by



which they are affected. In these cases the symptoms may be merely a somnolent condition and occasional attacks of fretfulness.

According to Professor C. J. Blake, whose advice to me regarding these cases has proved invaluable, as soon as an aural complication is detected the treatment of the naso-pharynx should be begun. The nose and naso-pharynx should be kept as clean as possible. The ear should be gently inflated by means of a Politzer bag. Pain should be combated by the instillation of a solution of atropine in glycerin and water into the ear (Prescription 70) and by the application of dry warmth. In addition to this, an opiate should, if required, be given internally.

PRESCRIPTION 70.

<i>Metric.</i>		<i>Apothecary.</i>	
	Gramma.		
R Atropinæ sulphatis . . . .	0   06	R Atropinæ sulphatis . . . . .	gr. i;
Glycerini,		Glycerini,	
Aq. destil. . . . .	āā 3   75	Aq. destil. . . . .	āā 3i.
M.		M.	

Sig.—Three or four drops to be warmed and dropped into the ear once every three hours.

The congestion should be controlled as far as possible by the internal administration of bromide of potassium in small and frequently repeated doses. If these measures fail to give relief, and if there is an increase of inflammation in the middle ear, as shown by marked swelling and congestion, especially of the superior posterior portion of the membrana tympani, or by a bulging of the membrane, which is seen to be pressed outward by the fluid in the tympanum, paracentesis with the knife should be performed, always with antiseptic precautions and under good illumination. In the early stages of congestion a crescentic incision carried along the superior posterior border of the membrana tympani through the congested region, and resulting in free hemorrhage, will often cut short an acute process. A free incision in the most prominent portion of a bulging membrana tympani, by giving a vent to the contained pus, may result in speedy relief from both pain and fever, and justifiably forestall the effort which nature is making to obtain this relief. In the acute congestive stage, after incision of the membrana tympani drainage-wicks made of dry absorbent cotton should be applied, and covered at their outer end with a pad of absorbent cotton filling the concha. These wicks should be renewed as often as both the wick and the cotton pad become saturated. The dressing should be kept strictly aseptic. After the paracentesis of the membrana tympani, in suppurative cases the ear should be syringed frequently with a weak, warm solution of bicarbonate of soda, then carefully dried by means of absorbent cotton, and, after the first few days, dressed by the insufflation of powdered boracic acid, while vaseline may be applied to the canal and concha to guard against the excoriation of the skin.

The after-treatment of the middle ear in these cases where there is no perforation of the membrana tympani should consist in gentle inflation by

means of the air-douche used in accordance with the evidence afforded by hearing-tests and by the objective examinations. In cases where there is perforation of the membrana tympani with continued suppurative discharge, thorough cleansing should be employed. If under this treatment improvement does not soon take place, the patient should be referred to an aurist.

I have already referred to the importance of detecting at once a complication of the ear during the progress of a case of scarlet fever and immediately treating it. Children are so often rendered deaf by the morbid processes resulting from the scarlet fever contagium that it becomes a positive duty for the attending physician to watch the ear as carefully in these cases as he would watch the heart in a case of rheumatism. In addition to the danger arising from a chronic disturbance of the tissues of the ear, you must carefully look for any evidence of the rapid extension of secondary infection from the naso-pharynx to the middle ear, and thence through the petro-squamosal suture to the cerebral meninges, a series of complications which usually proves fatal.

I recently saw a case in consultation with Dr. Forster which illustrates the danger of not treating promptly and thoroughly the complication of otitis in cases of scarlet fever.

A child (Case 242) two and a half years old had been attacked with scarlet fever and later with a complicating purulent otitis. When I saw the child it was lying in a state of stupor, apparently induced by pressure on the cerebral blood-vessels of an unusually large collection of pus in the middle ear through the petro-squamosal suture. In this case rupture had taken place in both membranæ tympani, and the pus was flowing in large quantities from the external meatus. A careful examination by Professor J. O. Green showed, however, that the perforations of the membranæ tympani were very minute, and the cerebral stupor was not relieved until a free opening was made in each tympanum and the entire middle ear thoroughly syringed out. Although the symptoms of pressure were relieved by these procedures, secondary infection of the cerebral meninges had already taken place, and the boy subsequently died of an acute purulent meningitis.

This case warns us that we should not be misled by the idea that a simple flow of pus from the auricle is necessarily sufficient to provide a proper exit for collections of pus in the middle ear, and that, unless the case is in the hands of an expert aurist, cerebral pressure or purulent meningitis is likely to occur at any time. It also represents a class of cases to which I shall refer again when speaking of meningitis, and illustrates one of the secondary forms of that disease.

**Kidney.**—I have spoken somewhat at length in the earlier part of this lecture concerning the albuminuria which is present in the different stages of scarlet fever, and also of the different forms of nephritis which may occur. What I hope I have impressed upon you is the great importance of detecting by means of frequent analyses of the urine the beginning of either the milder forms of renal disturbance or the more severe forms of nephritis, usually represented by that which is called capsular glomerulo-nephritis. If carefully watched for, the appearance of albumin will almost always precede the clinical symptoms, and by a still more rigid enforcement of the rules which I have laid down as practically governing the treatment the further development of a nephritis may be prevented or at least rendered



much less pronounced. It is quite frequently the case that a suspicion is first aroused of the presence of a nephritis either by vomiting or by œdema of the face, especially about the eyes, and commonly occurring during the period of desquamation, from the eighteenth to the twenty-fourth day. Under these circumstances the urine will be found to be diminished in quantity and to contain albumin. The daily amount of the urine may be reduced as low as 100 c.c. ( $3\frac{1}{2}$  ounces), or even lower. The microscopic examination of the urine does not differ materially from that which results from the other forms of nephritis in their early stages, but later you may possibly find that fatty casts are less numerous in the nephritis of scarlet fever, because there is less fatty degeneration in the renal epithelium. The earlier in the course of the disease the symptoms of nephritis appear, the more severe, as a rule, will be its type. The extent of the albuminuria is of less consequence than the total quantity of the urine. A rapid and extensive diminution of the urine is ominous, as it indicates the accumulation of nitrogenous waste in the blood and the danger of a resulting uræmia. The albumin occurring early in the disease is more apt to be in large quantities than when it appears first in the third or fourth week. Hæmaturia is frequently present in this form of nephritis, but ordinarily of itself adds little to the gravity of the disease. The œdema of the face may be followed by a rapid involvement of the ankles and legs and at times may become general. During the course of a general œdema the desquamation is apt to cease, returning on its disappearance. The œdema may last for months or may pass away quickly; it may be entirely absent, but in such cases the nephritis is almost invariably of a light grade.

At times during the presence of a general œdema serous effusions into the pleura may occur. Œdema of the lungs and brain, though rather rare, may also take place. Instead of a slow development beginning with œdema of the face we may have an acute attack, ushered in by fever, vomiting, headache, œdema, amblyopia, coma, and convulsions.

Relapses may occur many weeks after an attack of scarlatinal nephritis, and we should watch the case with the greatest care for several months. The nephritis of scarlet fever, although it may last for months, has a tendency in children ultimately to disappear, on account of their wonderful recuperative powers. It is also rare for the renal disease following scarlet fever to become chronic.

Retinitis and amaurosis at times occur during the progress of the nephritis in scarlet fever. In these cases of amaurosis it has been noticed that, although the loss of sight may be complete, almost always where uræmia and amaurosis are coincident there are found no perceptible change in the retina, no congestion of the papillæ, no increase of intra-cranial pressure, and no intense œdema of the brain. The sight, under these circumstances, may be recovered completely.

The alterations in the glomeruli already spoken of not only cause the anuria and the uræmia, but also obstruct the renal arteries, as very



nearly all the renal blood has to pass through the glomeruli. We find in quite a large number of cases of capsular glomerulo-nephritis a rapid hypertrophy of the left ventricle. This cardiac complication is not to be confounded with the endocarditis which I have already spoken of as secondary to the scarlet fever, and which is supposed to be caused by its special poison or by the streptococci which I have already described as being present in the disease. It is, in fact, not the direct result of the scarlet fever, but is secondary to the nephritis, and is, in this sense, tertiary to the scarlet fever. We therefore do not find this acute cardiac hypertrophy in the earlier stages of scarlet fever, but when a capsular glomerulo-nephritis is once established it may take place in so short a period as a week. This rapid hypertrophy has usually been observed in children between the ages of three and six years, which is of some significance in explaining why this hypertrophy should take place so easily. If you will recall what I have already told you in my lecture on development (Lecture IV., page 122), you will understand that between the ages of three and eight years a physiological hypertrophy of the heart exists, possibly caused by a continuance of the aortic narrowing in the neighborhood of the ductus arteriosus, and that the heart will be more readily affected by increased blood-pressure at that age. This tendency to change in the cardiac muscles is also accentuated by the rapid growth of the organ at this period of life. Besides the cardiac hypertrophy we may, at times, have an acute dilatation of the heart in these cases. This is a serious complication, which must be guarded against, and when it occurs must be recognized at once. These cardiac complications very frequently recover completely, as it is seldom that any extensive changes in the muscles of the heart take place.

Although the occurrence of sugar in the urine during the course of scarlet fever is very rare, yet it is well to examine the urine for this element in cases of scarlet fever. By taking this precaution it will sometimes be possible to explain some otherwise obscure symptoms which may arise.

Dr. Zinn, of Bamberg, reports the case (Case 243) of a boy, four years old, previously strong and healthy, who was attacked with scarlet fever and diphtheria on January 27. The diphtheria was light in form and gradually subsided, but on the thirteenth day from the time when the child was seized with scarlet fever an otitis externa appeared, accompanied by excessive vomiting and by the rapid development of oedema and ascites. The urine showed evidence of nephritis by being lessened in quantity and by containing a large amount of albumin and numerous casts and blood-corpuscles. After a few days the more dangerous symptoms passed off, and the patient was treated with hot baths and injections of pilocarpine. Although the appetite improved considerably, the child's strength did not return, and he remained in bed during the whole of March. Early in April, on attempting to walk he was found to have paralysis of the right leg, which soon passed off. At this time there was a slight trace of albumin in the urine. He then began to show an increased action of the heart, and an examination of the urine on the 10th of April showed that the specific gravity was 1030 and that it contained a considerable amount of sugar. The total amount of urine passed in twenty-four hours was somewhat decreased. The appetite at this time was good, the thirst was not noticeably increased, and nothing else abnormal was discovered. The child was placed on a diet of meat, milk, eggs, and red wine, and

by the 30th of April there was only one per cent. of sugar in the urine, and by the middle of May only one-fourth of one per cent. From this time the child improved in strength and was allowed to have a mixed diet. By the middle of June the urine was found to be free from sugar and albumin, and the child became as strong and as well as ever.

I have already told you that very little treatment beyond hygienic measures is needed for the mild uncomplicated cases of scarlet fever. This can hardly be said of the cases that are complicated with severe forms of nephritis, for in these we must act promptly and with great judgment.

We should be careful about using diuretics which might irritate the kidney. Acetate of potash is one of the safer diuretics in this complication. In the lighter cases a lemonade made with bitartrate of potash will be taken well, and will often quickly increase the quantity of the urine, reduce the œdema, diminish the albumin, and cause a radical change for the better. This lemonade may be made by using 4 c.c. (1 drachm) of bitartrate of potash to 473 c.c. (1 pint) of boiling water into which a lemon cut in thin slices has been dropped. This quantity a little sweetened may be drunk in twenty-four hours by a child five years old.

In severe cases with general œdema and threatening uræmia cathartics are rather more certain in their action than diaphoretics and diuretics, and are especially indicated where, as is usually the case, constipation is present. Podophyllin in doses of 0.006 gramme ( $\frac{1}{160}$  grain) may be given to a child five years old, and repeated a number of times. It usually acts quickly. The compound jalap powder in doses of 0.3–0.6 gramme (5–10 grains) may also be given where a rapid and decided derivation by the intestine is indicated.

Having provided for the proper movement of the bowels, if the skin is hot and dry, and uræmic symptoms, usually represented by anuria, somnolence, amblyopia, and headache, are present, the hot pack, either wet or dry, should be resorted to. I prefer in these cases to have the child wrapped in a blanket and placed directly in a tub containing water at a temperature of 40.5°–43.3° C. (105°–110° F.). The child should be kept in the water fifteen or twenty minutes, and even longer if necessary, and should then be taken from the wet blanket, enveloped in hot, dry blankets, and kept in them until the skin has become moist and reaction has taken place. While the child is in the bath, milk can be given to it, and stimulants if they are indicated by a weak or an intermittent pulse.

In addition to this treatment, muriate of pilocarpine in doses of 0.003 gramme ( $\frac{1}{200}$  grain) should be given by the mouth to a child of two years, and subcutaneously, if desired, to a child five years of age. In these cases of threatening uræmia, convulsions sometimes appear quite suddenly. Under these circumstances enemata of hydrate of chloral, 0.3–0.6 gramme (5–10 grains) dissolved in water, are of value in controlling these nervous phenomena. I myself prefer to use a combination of bromide of potash and hydrate of chloral, such as you see in this prescription (Prescription 71):



## PRESCRIPTION 71.

<i>Metric.</i>	<i>Gramma.</i>	<i>Apothecary.</i>
R Chloral. hydrat. . . . .	7   5	R Chloral hydrat. . . . . ℥ii;
Potassii brom. . . . .	15   0	Potassii brom. . . . . ℥iv;
Aq. destil. . . . .	90   0	Aq. destil. . . . . ℥iii.
M.		M.

Sig.—3.75 c.c. (1 drachm) in 30 c.c. (1 ounce) of warm water: to be given by enema, and repeated in half an hour if needed

Where the ascites is extreme, paracentesis abdominis is often of great value, not only in relieving the pressure, but also in increasing the action of the diuretic, which, perhaps, before was not acting freely. Digitalis is a valuable remedy especially adapted to the treatment of the nephritis of scarlet fever and to that of the cardiac changes which result from it. By the administration of this drug the flow of urine is increased. It is best given in the form of a freshly prepared infusion, in teaspoonful doses every four hours to a child five years old. Diuretin, 0.3 gramme (5 grains), dissolved in water and given two or three times in the twenty-four hours, has proved of considerable value in my cases, and is apparently harmless.

I speak of special ages, such as five years or two years, merely as a guide by which you can judge what the proper doses should be at the other ages.

In addition to these more common complications of scarlet fever a number of secondary infections are at times met with. Thus, cases of purpura following or complicating scarlet fever have been reported, and are usually fatal.

An acute inflammation of the joints, usually the larger ones, is not infrequently met with during the course of scarlet fever. This acute synovitis is at times apparently either due to or closely connected with rheumatism, and may be accompanied by endocarditis and pericarditis. The latter disease is, however, rarely met with unless in the later stages of scarlet fever in cases where nephritis has developed. These rheumatic cases are usually controlled by the administration of salicylic acid. As a rule, they are not of long duration, and if effusion takes place in the joints it is serous, does not become purulent, and does not give an especially serious prognosis.

In connection with these cases, either uncomplicated or where the heart is also affected, chorea has sometimes arisen as a complication.

A more severe form of synovitis, apparently caused by sepsis, may also occur during the course of scarlet fever. The effusion in the joints in these cases may become purulent and lead to serious and permanent disorganization of the tissues and often to death from general septic infection.

Besides these acute inflammations of the joints a chronic process at times arises, appearing, as a rule, very late in the disease or subsequent to it by many months. This inflammation is tubercular in character, and affects with especial frequency the hip and knee. Although tubercular, it seems to be a late result of the original toxic effect of the micro-organisms of or secondarily connected with the scarlet fever contagium.



A case which I saw in consultation with Dr. Miller, of Providence, represents so well one of the milder forms of what was probably capsular glomerulo-nephritis, and the effect of rest in the treatment of the disease, that I shall report it to you.

A girl (Case 244), five years old, was attacked by scarlet fever of the benign form and very mild in its character. After the usual prodromal symptoms the efflorescence appeared and ran its course, and desquamation became established. At the end of the second week, and while the desquamation was still present, the child seemed so well that it was allowed to be dressed and about its room. It was also allowed to have its usual food, which included a considerable amount of meat.

On January 4 the child was very irritable during the day, and passed her urine involuntarily in the forenoon. During the afternoon she was feverish, and passed frequently small amounts of urine. That night she slept well, but on awaking on the morning of January 5 she seemed dull, and was said to be feverish and to have little appetite.

On January 6 the record stated that she had passed only 90 c.c. (3 ounces) of urine in the twenty-four hours. She seemed tired and languid, and there was an œdematous condition of the eyes and upper part of the face. She had one normal movement of the bowels.

On January 7 the total amount of urine passed in the twenty-four hours was 480 c.c. (16 ounces). She was given infusion of digitalis and cream of tartar water on this day, and placed on a diet of milk.

On January 8 she seemed better, and passed 480 c.c. (16 ounces) of urine in the twenty-four hours. She was then allowed to have an increase in her diet, consisting of broth and various kinds of soups. An examination of the urine (Analysis 61) by Professor E. S. Wood on this day gave the following result:

## ANALYSIS 61.

Color . . . . .	Rather pale.
Reaction . . . . .	Acid.
Urophæin . . . . .	Diminished.
Indoxyl . . . . .	Increased.
Urea . . . . .	Diminished.
Uric acid . . . . .	Increased.
Albumin . . . . .	Considerable trace.
Sugar . . . . .	Absent.
Bile-pigments . . .	Absent.
Specific gravity . . .	1009.
Chlorides . . . . .	Almost absent.
Earthy phosphates .	Diminished.
Alkaline phosphates .	Diminished.
Sediment . . . . .	Slight in amount; consisted chiefly of normal blood-globules, a few renal cells, and a few hyaline, fibrinous, blood, and epithelial casts. The blood-globules and the casts were normal in appearance.

In regard to this examination Professor Wood remarks that the important features of the urine were its dilution, the great diminution in the normal salts, especially in the chlorides, the considerable trace of albumin, and the blood and casts. The normal character of the blood-globules and the comparatively small number of the casts seemed to show that only a small portion of the kidney was affected. At the time of the great diminution in the quantity of the urine the tubules were probably nearly completely blocked up. The low specific gravity and the great diminution of the urica and chlorides seem to indicate that it would need but little additional irritation to produce a marked nephritis. The present condition seems to be one of a mild nephritis.

The general symptoms presented by the child and the disturbance of the kidney shown by the examination of the urine made me advise that she should be kept in bed in a warm room and placed on a diet exclusively of milk. A warm bath was to be given once or twice

daily until a larger amount of urine was passed, and 4 c.c. (1 drachm) of infusion of digitalis administered four times in the twenty-four hours.

On January 9 the total amount of urine passed in the twenty-four hours was reduced to 90 c.c. (3 ounces), and the child was nauseated and vomited a number of times during the day.

On January 10 she was reported to have had a very restless night and to have been very much excited on waking. She had no pain anywhere. Her face continued to be œdematous. The total amount of urine passed in the twenty-four hours was 240 c.c. (8 ounces). She perspired slightly, and had one large, loose dejection. She so absolutely refused to take milk that she was given 103 c.c. ( $3\frac{1}{2}$  ounces) of beef juice, which was all the nourishment that she took on this day.

On January 11 the face was more œdematous, and she was languid. She had two large, loose, offensive dejections from the bowels, and complained of a burning sensation in the rectum at the time of the movements. The total quantity of urine was 300 c.c. (10 ounces). On this day she was finally persuaded to take milk, and no other food was given to her.

On January 12 the child seemed brighter and the face was not so much swollen. The total amount of urine in the twenty-four hours increased to 540 c.c. (18 ounces), and an analysis (Analysis 62) made by Professor Wood gave the following results:

#### ANALYSIS 62.

Color . . . . .	Normal.
Reaction . . . . .	Acid.
Urophæin . . . . .	Diminished.
Indoxyl . . . . .	Increased.
Urea . . . . .	Slightly diminished.
Uric acid . . . . .	Increased.
Albumin . . . . .	A slight trace, and less than on January 8.
Sugar . . . . .	Absent.
Bile-pigments . . . .	Absent.
Specific gravity . . .	1014.
Chlorides . . . . .	Almost absent.
Earthy phosphates. .	Diminished.
Alkaline phosphates .	Diminished.
Sediment . . . . .	Considerable in amount, and consisting chiefly of numerous blood-globules, a few renal cells, an occasional hyaline and blood cast, and an occasional small epithelial cast.

This specimen showed that improvement had taken place in the condition of the kidney since the previous examination, as the albumin had lessened in quantity and the urea had increased.

On January 13 the total quantity of urine had increased to 1410 c.c. (47 ounces). The child seemed very well, and was reported to have slept quietly all night. An analysis of the urine showed the specific gravity to be 1011. The chlorides, though still much diminished, were beginning to reappear, which was a very favorable symptom.

On January 14 the total amount of urine was 1545 c.c. ( $51\frac{1}{2}$  ounces). The child continued to improve in appearance, and seemed bright and well.

On January 15 the total quantity of urine was 1440 c.c. (48 ounces), and on January 16 it was 1035 c.c. ( $34\frac{1}{2}$  ounces).

During the rest of the attack there was no notable change in the total amount of urine passed in twenty-four hours. The results of the analyses of the urine which were made from time to time showed that there was some process going on beyond a simple hyperæmia existing in the kidney. The urea remained diminished until the 12th of March, when it was found to be increased, and on the 22d of March it was normal. The chlorides continued to be diminished until April 7, when they were reported to be normal. The specific gravity remained below 1020 until April 13, when it became 1024. A slight trace of albumin continued to be found until the following autumn. An analysis (Analysis 63) of the urine made September 25 by Professor Wood gave the following results:

THE EXANTHEMATA.

ANALYSIS 63.

Color . . . . .	Normal.
Reaction . . . . .	Acid.
Urophæin . . . . .	Normal.
Indoxyl . . . . .	Normal.
Urea . . . . .	Normal.
Uric acid . . . . .	Normal.
Albumin . . . . .	Very slightest possible trace.
Chlorides . . . . .	Normal.
Earthy phosphates . .	Normal.
Alkaline phosphates .	Normal.
Specific gravity . . .	1017.
Sediment . . . . .	Slight, and consisting of a very few normal blood-globules. Slight excess of small round cells and of cells like those from the neck of the bladder.

Although a very prolonged search was made for casts, none were found. Professor Wood considered that at this date the kidneys had practically recovered, as they were doing perfectly normal work. The blood probably came from the neighborhood of the urethra, as there was irritation in that locality.

In April the child was allowed to have, besides her diet of milk, some broth and bread and butter, and in May she was given meat. She was kept in bed until the latter part of March.

During the course of her sickness various attempts were made to increase her diet more quickly and to allow her to be dressed and about the room, but each time when this was done she showed symptoms which pointed towards the presence of a renal complication, such as a swelling of the eyes and face and a rise of temperature, with resulting nausea and loss of appetite.

This case shows how careful we must be for many weeks and even months to control the temperature of the room, the amount of exercise, and the kind of food, where a nephritis has complicated a case of scarlet fever. It also shows how entire recovery may take place even where the renal irritation is pronounced and unusually prolonged.

This table (Table 94) gives the record of the total amount of urine passed in each twenty-four hours for ninety-two days.

TABLE 94.

Days.	C.c.	Ounces.	Days.	C.c.	Ounces.
1 . . . . .	90	3	21 . . . . .	855	28½
2 . . . . .	480	16	22 . . . . .	900	30
3 . . . . .	480	16	23 . . . . .	1020	34
4 . . . . .	90	3	24 . . . . .	1125	37½
5 . . . . .	240	8	25 . . . . .	1020	34
6 . . . . .	300	10	26 . . . . .	1185	39½
7 . . . . .	540	18	27 . . . . .	975	32½
8 . . . . .	1410	47	28 . . . . .	1260	42
9 . . . . .	1545	51½	29 . . . . .	990	33
10 . . . . .	1440	48	30 . . . . .	1155	38½
11 . . . . .	1035	34½	31 . . . . .	1230	41
12 . . . . .	930	31	32 . . . . .	1230	41
13 . . . . .	915	30½	33 . . . . .	1125	37½
14 . . . . .	930	31	34 . . . . .	1185	39½
15 . . . . .	900	30	35 . . . . .	1185	39½
16 . . . . .	1065	35½	36 . . . . .	1050	35
17 . . . . .	1095	36½	37 . . . . .	1005	33½
18 . . . . .	1065	35½	38 . . . . .	990	33
19 . . . . .	1140	38	39 . . . . .	1020	34
20 . . . . .	1020	34	40 . . . . .	1290	43



TABLE 94.—Continued.

Days.	C.c.	Ounces.	Days.	C.c.	Ounces.
41 . . . . .	1170	39	67 . . . . .	900	30
42 . . . . .	1215	40½	68 . . . . .	1275	42½
43 . . . . .	1020	34	69 . . . . .	1230	41
44 . . . . .	1110	37	70 . . . . .	1140	38
45 . . . . .	1095	36½	71 . . . . .	1275	42½
46 . . . . .	1425	47½	72 . . . . .	1185	39½
47 . . . . .	1305	43½	73 . . . . .	1230	41
48 . . . . .	1125	37½	74 . . . . .	1380	46
49 . . . . .	1230	41	75 . . . . .	1275	42½
50 . . . . .	1125	37½	76 . . . . .	1260	42
51 . . . . .	1155	38½	77 . . . . .	1230	41
52 . . . . .	1080	36½	78 . . . . .	1215	40½
53 . . . . .	1005	33½	79 . . . . .	1230	41
54 . . . . .	1080	36½	80 . . . . .	1140	38
55 . . . . .	1200	40	81 . . . . .	1230	41
56 . . . . .	915	30½	82 . . . . .	1305	43½
57 . . . . .	1215	40½	83 . . . . .	1230	41
58 . . . . .	1335	44½	84 . . . . .	1170	39
59 . . . . .	1245	41½	85 . . . . .	1200	40
60 . . . . .	1095	36½	86 . . . . .	970	29
61 . . . . .	1040	35	87 . . . . .	735	24½
62 . . . . .	1050	35	88 . . . . .	1235	34½
63 . . . . .	975	32½	89 . . . . .	930	31
64 . . . . .	935	31½	90 . . . . .	885	29½
65 . . . . .	990	33	91 . . . . .	885	29½
66 . . . . .	1050	35	92 . . . . .	1065	35½

This table (Table 95) shows the record of the total amount of milk taken by the child in each twenty-four hours during thirty-one days. Milk was her exclusive diet during these days, and although, as I have already told you, in the beginning of her sickness she disliked and refused to take milk, she was, nevertheless, persuaded to take it, and finally did so without resistance. The table is instructive as showing the amount of milk which is sufficient for nourishment for a child of this age.

TABLE 95.

Days.	C.c.	Ounces.	Days.	C.c.	Ounces.
1 . . . . .	630	21	17 . . . . .	1260	42
2 . . . . .	1440	48	18 . . . . .	1620	54
3 . . . . .	1530	51	19 . . . . .	1530	51
4 . . . . .	1440	48	20 . . . . .	1440	48
5 . . . . .	1440	48	21 . . . . .	1530	51
6 . . . . .	1440	48	22 . . . . .	1530	51
7 . . . . .	1440	48	23 . . . . .	1530	51
8 . . . . .	1260	42	24 . . . . .	1530	51
9 . . . . .	1260	42	25 . . . . .	1620	54
10 . . . . .	1260	42	26 . . . . .	1620	54
11 . . . . .	1260	42	27 . . . . .	1620	54
12 . . . . .	1260	42	28 . . . . .	1620	54
13 . . . . .	1440	48	29 . . . . .	1620	54
14 . . . . .	1350	45	30 . . . . .	1620	54
15 . . . . .	1350	45	31 . . . . .	1620	54
16 . . . . .	1350	45			

CASE 245.



I.—Before treatment.



II.—After treatment.

Scarlet fever. Nephritis; enlargement of the heart.





This boy (Case 245, I., facing page 568) whom you see here in the convalescent ward is an illustrative case of scarlet fever complicated by a probable capsular glomerulo-nephritis and a resulting cardiac enlargement.

He is seven years old, and entered the hospital on July 28. His mother is living and well, and states that his father died of Bright's disease. The child is said to have been well until eighteen months ago, when he had an attack of scarlet fever, mild in form and not accompanied by any severe symptoms. In the latter part of the attack his temperature rose, and he began to have dyspnœa and dropsy. Since that time he has been slowly but steadily growing worse. As you see, he has extensive œdema of the face, chest, arms, abdomen, and legs. He is somewhat cyanotic, and his breathing is so much affected that he is unable to lie down, the orthopnœa compelling him to be supported in a semi-recumbent position. On closer examination you see that there is a slight puffiness about both eyes, that there is a yellow tinge of the conjunctivæ, and that the lips and tongue are cyanotic. The extremities are cold to the touch, and their skin pits readily on pressure. The skin of the whole body is dry and harsh and in certain portions is covered with fine scales. On the inner side of the left leg and on the outer side of the right leg are some old scars, apparently resulting from a previous scarification performed for the reduction of the anasarca. In addition to the œdematous condition of the walls of the abdomen, a distinct fluctuation is found on palpation, showing that there is fluid in the abdominal cavity. An examination of the lungs shows that there is dulness over both bases behind, and over these areas of dulness, as well as over the whole front of the chest, fine moist râles can be heard, indicating an œdematous condition of the lungs. On examining the heart, I find that its impulse is most distinct in the sixth interspace a little outside of the mammary line. The area of cardiac dulness extends from the second rib on the left to 2.5 cm. (1 inch) to the right of the sternum, in an area corresponding to the third interspace and fourth rib. The dulness then extends to the left across the sternum to a point 2.5 cm. (1 inch) outside of the mammary line and as low as the sixth interspace, corresponding to the cardiac impulse. A loud systolic murmur can be heard over the region of the cardiac impulse, and is transmitted so that it can be heard in every part of the thorax. The total amount of urine in twenty-four hours has varied from 900 to 1050 c.c. (30-35 ounces). An analysis (Analysis 64) of the urine gives the following results :

## ANALYSIS 64.

Color . . . . .	Darker than normal.
Specific gravity .	1013.
Reaction . . . . .	Acid.
Urophæin . . . . .	Diminished.
Indican . . . . .	Increased.
Chlorides . . . . .	Diminished.
Albumin . . . . .	$\frac{4}{10}$ per cent.
Sugar . . . . .	Absent.
Sediment . . . . .	Very slight and flocculent. Microscopic examination shows numerous short hyaline and granular casts of medium diameter and occasionally of small diameter; an excess of renal epithelium; considerable abnormal blood; an occasional white corpuscle; one or two blood-casts, many hyaline and granular casts, with one or more renal cells adherent; occasional fatty renal cells and casts with a few fat-drops adherent.

On entering the hospital yesterday he had a slight diarrhœa. You see that to-day he is unable to lie down with comfort, on account of the dyspnœa arising from an accumulation of fluid in the abdomen. The legs are also very much swollen and œdematous. His face is somewhat puffy. The cyanosis is so marked and the child is in so much distress that it is evident that immediate relief should be given not only to the general symptoms, but also to

the great tax which is being imposed upon the already disabled heart. Unless some relief to these symptoms is given, it is very likely that he will die suddenly from heart-failure. I shall, therefore, withdraw a certain amount of fluid from the abdominal cavity, which will, I think, be followed by considerable relief to the dyspnoea. You see that I have first assured myself that the bladder is empty, have then had the child supported on the side of the bed with the legs apart, have introduced a trocar into the median line of the abdomen just below the umbilicus, and have withdrawn 480 c.c. (16 ounces) of clear, yellowish fluid. You will notice that the child already breathes with much greater freedom and that the cyanosis is decidedly diminished.

This case illustrates some of the points in the pathology and clinical symptoms of scarlet fever to which I have already referred. Of course at as late a stage of the disease as that when the boy entered the hospital it would be impossible to make a definite diagnosis as to the condition of the kidney and heart which may have existed at an earlier stage. It is possible that during the stage of efflorescence an endocarditis such as might complicate the earlier symptoms of scarlet fever may have been present and may have been followed by a pathological lesion of the valves. The history of the case, however, states that the course of the scarlet fever was a mild one in its early stages, and that whatever complications followed arose at a later stage of the disease, during desquamation. It would seem probable, therefore, that the symptoms of oedema and cyanosis which appear in this later stage of the disease were caused by a disturbance of the kidney. As I have already told you, a renal complication is most common in the later stages of scarlet fever. The physical examination made when the child entered the hospital showed that there was a complication of the heart, represented by cardiac enlargement and a mitral systolic murmur. The examination of the urine shows us that it is probable that there are organic changes in the kidney as well as in the heart, although we cannot say definitely that such conditions as we find in the urine have not been produced by a cardiac lesion followed by passive congestion of the kidney. Therefore, although we cannot decide without a post-mortem examination whether both kidney and heart are affected, we can at least suppose that the following sequence of complications has resulted and has produced the present clinical symptoms.

The child had scarlet fever in a mild and apparently uncomplicated form until he reached the stage of desquamation. During the latter part of this stage a lesion of the kidney, presumably of the capsular glomerular form, occurred, and, owing to the increased blood-pressure which finally resulted from the changes in the kidney, hypertrophy of the heart, presumably followed by dilatation, appeared. If I have correctly read this sequence of lesions, we have, then, cardiac enlargement secondary to a renal disease and tertiary to the original scarlet fever contagium.

The prognosis in this case is very unfavorable. Although we know that in children dilatation of the heart may be entirely recovered from, yet as long as this condition exists there is danger of sudden death from cardiac failure. Where the cardiac dilatation results from extensive disease of the kidney, especially in the form which we most commonly meet with in scarlet fever, capsular glomerulo-nephritis, the chances are that this failure will take place before the nephritis has been recovered from when a patient has been reduced to such a degree as is the case with this boy.

The treatment should be absolute rest, so as not to tax the muscles of the heart more than can possibly be avoided. To relieve the intra-abdominal pressure, which augments the oedema of the lungs and interferes with the action of the heart, paracentesis of the abdomen should be performed, as I have just shown you. Hot baths should be given to increase the action of the skin, laxatives to relieve the congested condition of the kidneys, and non-irritating diuretics, such as acetate of potash and digitalis, are indicated. Nitro-glycerin is valuable where the action of the heart at any time becomes suddenly feeble and irregular.

(Subsequent history of the case.) For the next few days after paracentesis of the abdomen the child improved greatly, the dyspnoea ceased, the urine became of a better color and increased in amount, the cyanosis grew less, and, although the pulse was still small and feeble, the child showed great general improvement. In the course of a month the oedema was so much reduced that the child looked like a different person (Case 245, II., facing page 569).



THE EXANTHEMATA.

He was able to lie down with comfort, slept well, his appetite returned, and at one time he could even be moved about the ward in a wheel-chair. Some weeks later the eardiae symptoms returned, and he again began to have œdema and ascites, eyanosis and orthopnœa. The urine, as you see in the table (Table 96), varied considerably, but at no time did it show the great lessening which is found in cases of threatening uræmia. The symptoms were, indeed, mostly those of a crippled heart. At one time the temperature, without any assignable cause, rose to 41.1° C. (106° F.), and somewhat later it became subnormal. On September 4 the ascites had increased to such a degree that paracentesis of the abdomen had to be again performed.

On September 8 the œdema increased, and the urine was reduced to 450 c.e. (15 ounces). Diuretin was given in doses of 0.6 gramme (10 grains), which increased the flow of urine to 1230 c.e. (41 ounces). The diuretin given in these doses once or twice a day for some time continued to act successfully.

In October the action of the heart grew still weaker, the œdema of the lungs increased, and, although there had been a general improvement, the child grew progressively weaker during November. Early in December he was attacked with vomiting, had a weak and rapid pulse, gradually failed in strength, and on the 21st of December died suddenly. No autopsy was obtained.

The total amount of urine in this case, measured daily from July 29 to September 15, was as follows :

TABLE 96.

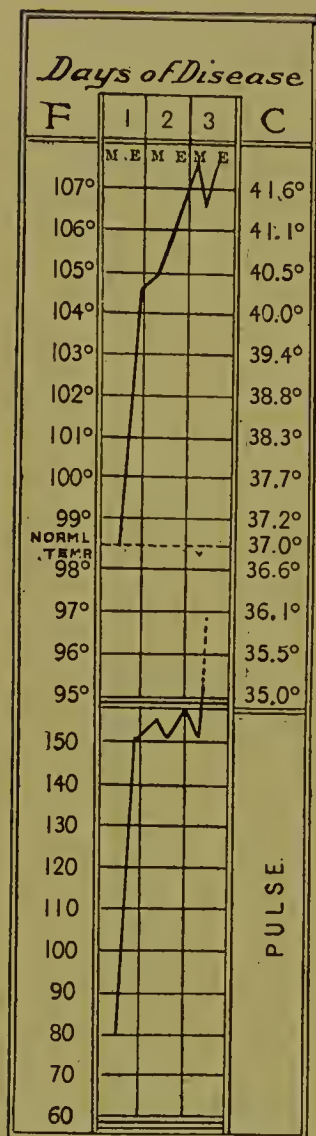
*(Total amount of urine passed in twenty-four hours during thirty-one days in a case of scarlet fever complicated by nephritis and resulting in cardiac dilatation.)*

Date.	C.e.	Ounces.
July 29 . . . . .	1440	48
July 30 . . . . .	1230	41
July 31 . . . . .	810	27
August 1 . . . . .	810	27
August 2 . . . . .	900	30
August 3 . . . . .	600	20
August 4 . . . . .	1320	44
August 5 . . . . .	990	33
August 6 . . . . .	630	21
August 7 . . . . .	510	17
August 8 . . . . .	510	17
August 9 . . . . .	840	28
August 10 . . . . .	1020	34
August 11 . . . . .	1020	34
August 12 . . . . .	720	24
August 13 . . . . .	1020	34
August 14 . . . . .	690	23
August 22 . . . . .	840	28
August 23 . . . . .	990	33
August 28 . . . . .	600	20
August 29 . . . . .	750	25
August 30 . . . . .	480	16
August 31 . . . . .	600	20
September 1 . . . . .	840	28
September 2 . . . . .	480	16
September 3 . . . . .	900	30
September 4 . . . . .	540	18
September 7 . . . . .	450	15
September 10 . . . . .	1230	41
September 14 . . . . .	660	22
September 15 . . . . .	750	25



**MALIGNANT FORM.**—I have told you in the beginning of this lecture that there are two distinct forms of scarlet fever, and I have spoken at length of the benign form, with its variations and complications, and its, as a rule, favorable prognosis. I shall have but a few words to say of the malignant form of scarlet fever, for it is almost without exception fatal, and is very rare in comparison with the benign form. Malignant scarlet

CHART 16.



Malignant form of scarlet fever. Girl, 11 years old.

fever appears to attack those individuals who have a predisposition to be profoundly affected by the scarlet fever contagium. In these cases we see healthy children attacked with intense headache, high fever, delirium, sometimes coma, and death follows usually in two or three days. A case of this kind was seen by me in consultation with Dr. Emerson, of Concord, and represents so well the conditions which are present in these cases of scarlet fever that I shall report it to you.

A girl (Case 246), eleven years old, was perfectly well and strong and had no other diseases up to January 10. In the middle of the day she felt very ill and vomited. Her pulse was 150, temperature 40.2° C. (104.5° F.). The pharynx and tonsils were much reddened, but there was no exudation or membrane to be seen. An efflorescence of a scarlatinal type appeared on the chest in the afternoon. The vomiting continued through the night and up to the morning of January 11. The child was conscious, but dull. The pulse was 150, and the temperature was 40.5° C. (105° F.). At 4 P.M. the face became puffy, and the efflorescence was well marked on the body and extended to the extremities. The child was wandering and stupid, and the temperature rose to 42.2° C. (108° F.). The extremities became livid, and the vomiting began again. At 6.30 P.M. the temperature, after the internal administration of various remedies, was found to be 41.1° C. (107° F.), and at 10 P.M. 41.1° C. (106° F.), and the pulse 160, weak and difficult to count. At 6 A.M. on the 12th, forty-eight hours from the appearance of the first symptoms, the child died.

The case was a perfectly hopeless one from the beginning, as every method of treatment which could be thought of was tried and proved absolutely fruitless. Tub bathing with water at different temperatures, and finally sponging with ice-water, had no effect whatever on the temperature or the general symptoms.

This chart (Chart 16) shows the temperature from the time of the attack to within a few hours before death.

## LECTURE XXVI.

## THE EXANTHEMATA.—(Concluded.)

## MEASLES.—RUBELLA.

**MEASLES** (Rubeola).—Measles is one of the most common diseases of childhood, and has been known for many centuries. It is an acute infectious disease, evidently caused by a specific micro-organism. It is characterized by lachrymation, photophobia, coryza, cough, a papular efflorescence, and a slight desquamation. The micro-organism which produces measles has not yet been determined. It is supposed to find its vehicle in the tears, and in the secretion of the throat and nose, and possibly to exist in the blood. Its tenacity for clothing, thus continuing as a fresh source of infection, is mild in comparison with that of scarlet fever. It is very infectious, and in some communities is at times exceedingly fatal. This was the case in the epidemic of 1873 in the Fiji Islands, where it had not occurred for a long time; it spread rapidly, and caused two thousand deaths, of which sixty-seven per cent. were in children under five years of age. The high mortality in measles is, as a rule, not caused by the measles itself, but by its complications. The epidemics of measles, as I have already told you in comparing the disease with scarlet fever, spread rapidly and appear to have an element of periodicity. This has been well exemplified here in Boston, in the crowded districts at the North End, where in certain years large numbers of children are affected, and where in the succeeding years the disease appears only sporadically. Measles can occur three or four times in the same individual: this recurrence was one of the peculiar features of the epidemic in Boston in 1880. It may attack young infants, but is rare under six months. After the sixth month, and especially during the first year, the susceptibility to the disease is increased, and we meet with the greatest number of cases between the first and the fifth year. The susceptibility to measles appears to lessen as puberty is approached. It is somewhat rare in adult life, though the fact of its attacking large numbers of adults was also a peculiarity of the epidemic of 1880 in Boston.

Measles is an extremely infectious disease, the contagium apparently passing from one individual to another after a very short exposure, and often without any direct contact, as by transmission through clothing or by the hands. It is most infectious in the beginning of the attack, and the infection may be transmitted three or four days before the efflorescence appears on the skin. There seems to be much less liability for the transmission of the disease during the stage of desquamation than is the case in some of the other exanthemata, such as scarlet fever and variola, the means of



transmission corresponding more to that of varicella. In speaking of scarlet fever I have already referred to the case (Case 234, page 533) of the little girl who, although exposed to the scarlet fever infection in the beginning of the disease, did not contract it, but in the following year, when exposed for a shorter time to the contagium of measles, was immediately infected by that disease. The following cases which I shall report to you will be interesting and instructive as examples of how the transmission of the contagium of scarlet fever can be prevented by treatment, and will also illustrate the high degree of the infection in the early stages of measles.

A boy (Case 247) who was in my ward at the Children's Hospital was attacked with scarlet fever.

I had him removed to the contagious ward and placed under the care of a special nurse, who had orders to carry out the most precise antiseptic treatment. The directions to the nurse were that she should apply an ointment to the child, rubbing it into the skin thoroughly from the head to the feet twice daily. The child was also to be bathed twice daily with a solution of corrosive sublimate, 1 to 10,000. The nurse was cautioned not to allow her clothes to touch the boy's bed.

During the early stage of this boy's desquamation a second boy (Case 248), who occupied the bed in the general ward next to the bed from which the first boy had been removed, was attacked with sore throat, vomiting, and fever. I had already paid my visit for the day, and my house officer, thinking the case was probably one of scarlet fever contracted from having been in such close proximity to the bed from which the first boy was taken, had the second boy removed to the contagious ward and placed in the same room with the first boy. On the following morning I found that the second boy did not have scarlet fever, but had measles. I immediately had the second boy removed to another room, and he was carefully watched for a week, supposing that having passed the night with the first boy, who was in the most infectious stage of scarlet fever, he might have contracted scarlet fever. A week passed, and he evidently had escaped infection by the scarlet fever contagium.

Ten days later the boy who had scarlet fever was attacked with measles, presumably contracted during the night from the boy who was his room-mate in the early stage of his attack of measles.

These two cases apparently show—first, that scarlet fever, even during its most infectious stage, can be prevented from spreading by thorough and constant disinfection; second, that measles is highly contagious in its early stages.

**PATHOLOGY.**—Beyond the morbid conditions which appear on the *skin* and on the mucous membrane of the *throat*, there is no especially characteristic pathology of measles.

Neumann has studied the pathology of the skin in measles by means of specimens which were hardened in a dilute solution of chromic acid and colored with carmine, hæmatoxylin, and picro-carmine. The pathological changes were found to be almost entirely confined to the glands of the skin and to the blood-vessels. About the walls of the blood-vessels, principally in the upper layers of the cutis, were found collections of round cells which in crowded masses surrounded the loops of the blood-vessels even in the papillæ. The blood-vessels themselves were dilated and full of blood. The coils of the sweat-glands, as well as the excretory ducts, were enveloped in accumulations of round cells, while the neighboring tissues were filled



with these cells. These collections of cells were always situated outside of the walls of the glands. The sebaceous glands presented like changes. The hair-follicles showed rounded protuberances which corresponded to the points of insertion of the *erectores pilorum*, and which were probably caused by contraction of these muscles. In the muscles themselves there were to be found, between the cells proper of the muscular tissue, scattered round cells, which showed the participation of the muscular tissue in the inflammatory process. The hair-follicles, in the same manner as the sweat-glands, were seen to be surrounded in their entire length by collections of round cells, which were more numerous in the lower than in the upper part of the skin. We therefore see that in measles the pathological process in the skin affects chiefly the blood-vessels and glands, while the tissue proper of the skin, as well as of the epithelium, presents no marked changes.

From the fact that in measles the pathological processes of the disease are situated more particularly around the blood-vessels and cutaneous glands, it may be assumed that the infectious material of the malady, whatever its nature, is eliminated from the system through these channels.

In addition to the pathological lesions which occur in the uncomplicated cases of measles, there is almost always associated with the catarrhal condition of the mucous membrane of the upper air-passages a catarrh of the larger bronchi. One of the most common complications of measles is pneumonia; this is usually a broncho-pneumonia, lobar pneumonia being comparatively rare.

In some cases an inflammation of the smaller bronchi accompanied by pulmonary collapse occurs. The bronchial glands are apt to be swollen if the secondary infection is a severe one. According to Osler, a swelling of Peyer's glands is not uncommon, and may be accompanied by a hyperæmic condition of the mucous membrane of the gastro-enteric tract.

Although a secondary infection of the ear has been considered rather distinctive of scarlet fever, this complication has in my experience arisen also quite frequently in measles. When the ear is affected in measles there is a congestion of the middle ear. When the onset of the preliminary congestion occurs in connection with the inflammation of the nasal and naso-pharyngeal mucous membrane, it consists of a simple, general, acute congestion of the middle ear, accompanied in the beginning with serous exudation, and later with a rapid thickening of the *membrana tympani* in connection with the inception of the suppurative process. When, on the other hand, the preliminary congestion is coincident with or follows the efflorescence on the face, the congestion is primarily in the upper portions of the *membrana tympani* as the result of a suspension of vaso-motor inhibition. Under these conditions there is a congestion of the *manubrial plexus*, of the superior and posterior portions of the *membrana tympani*, and of the corresponding portions of the inner end of the external auditory canals.

In addition to this more common condition, a general congestion of the *membrana tympani* is found during the stage of efflorescence, and is likely

to be more severe in its type than that which occurs during the prodromal stage of measles.

The inflammation of the middle ear accompanying measles is more likely to leave behind such trophic changes as thickening of the tympanic mucous membrane with the formation of adhesions than is scarlet fever.

During an attack of measles, and subsequent to it, the tissues show an especial vulnerability to infection by the bacillus of tubercle. The tubercular infection may be represented by the lesions of a general miliary tuberculosis or by those of especial tissues, such as of the cervical and bronchial glands, the joints, the ear, and, most commonly of all, the lung. In the latter instance the lesions are usually those of a tuberculous bronchopneumonia.

**INCUBATION.**—The time of the incubation of measles may vary very much, and may cover a period of two or three weeks; the usual time, however, is ten days.

**SYMPTOMS.—Prodromata.**—The prodromal stage varies in length, but, reckoning ten days as the usual time for the stage of incubation, the prodromal stage may be considered to last from two to three days, and in some cases four days. In this stage we have in typical cases of the disease symptoms distinctive of measles. The invasion is characterized by severe catarrhal conditions affecting the nose (coryza), the eye (lacrimation), and the throat and upper air-passages (cough). In the first twenty-four hours the temperature rises to  $38^{\circ}$  or  $39^{\circ}$  C. ( $100.4^{\circ}$  or  $102.2^{\circ}$  F.), and often to  $40^{\circ}$  C. ( $104^{\circ}$  F.). The height of the temperature on the first evening is a fair indication as to the severity of the coming disease. Thus, a temperature of  $40.5^{\circ}$  C. ( $105^{\circ}$  F.) indicates a severe case. An important point to be noticed regarding the prodromal symptoms is that after the first twenty-four hours there is in a large number of cases a remission in the temperature, which goes down, perhaps, to  $37.5^{\circ}$  or  $37^{\circ}$  C. ( $99.5^{\circ}$  or  $98.6^{\circ}$  F.), and remains down for about twenty-four hours, when it again rises. The cough, coryza, and lacrimation, which appear early in the prodromal stage, do not abate, but rather increase, during this remission of the temperature. This is an important point to remember, as the child who seems quite sick and loses its appetite while the temperature is high during the invasion of the disease, seems brighter and has a return of appetite on the second day when the temperature is lower. This peculiarity of the prodromal stage is often misleading both to the parents and to the physician, who, because the child appears so much better, are led to believe that one of the infectious diseases is not developing. In infants and young children the prodromal stage may begin with a convulsion, but this is unusual, and if it occurs it is not, as a rule, particularly severe, and does not necessarily make the prognosis more grave. Headache in the prodromal stage is quite frequent; vomiting is rather rare. The tongue is usually furred, and the mucous membrane of the throat towards the end of the second day, and before the efflorescence has appeared on the skin, shows a condition which is very



similar to that which is about to appear on the skin. These lesions, which are especially pronounced on the soft and the hard palate, are represented by papules or macules of a dark-red and later purplish-red color, of different sizes, and considerably larger than the punctate macules which I have described in speaking of the throat in scarlet fever. These papules may sometimes be found to have coalesced in some parts of the fauces. The mucous membrane between the lesions is comparatively normal in color, though there may be a slight hyperæmia of the entire throat. This hyperæmia, however, is not nearly so intense as is seen in the throat in scarlet fever. After the remission of the temperature, which I have already described as taking place on the second day, the temperature on the third or fourth day again rises.

**EFFLORESCENCE.**—At the end of the third day or at the beginning of the fourth day—that is, the thirteenth or fourteenth day from the time when infection took place—an efflorescence appears on the skin. The efflorescence usually reaches its maximum in about thirty-six hours, this being a more constant number than the other figures which I have given you; that is, it is about the fifteenth day from the date of infection. The stage of incubation is rather more constant than the stages of prodrome and efflorescence, the latter two varying as to their length, but together amounting to five or six days.

When the efflorescence appears on the skin it consists commonly of small macules or papules on a slightly reddened base, which first appear on the face. As the disease progresses, these lesions extend to the neck and chest, and in the latter locality are, especially in the beginning, of a delicate pink color, the form of distribution in some cases being crescentic. The efflorescence then rapidly extends to the rest of the body and to the extremities. It is usually more pronounced on the face, where the papules are apt to coalesce, and where an œdematous condition of the tissues, especially around the eyes and nose, usually occurs. The eyes are swollen and partially closed, and the conjunctivæ are reddened. Photophobia at this time is pronounced. The efflorescence may also appear on the scalp. The efflorescence remains well marked for from one to two days, and while it is at its height the temperature reaches its maximum, and remains high for two or three days, corresponding to the intensity of the efflorescence. It then rapidly falls, and reaches the normal point in about two days more,—that is, there appears to be often a distinct crisis in the disease. During the period of efflorescence, when the temperature is still raised and the efflorescence is at its maximum, it is usual to have, in addition to the symptoms of cough, coryza, and lachrymation, a slight disturbance of the intestines, represented by small, frequent, loose discharges, apparently arising from irritation of the rectum and descending colon. This condition is seldom a serious one, and no especial attention need be paid to it unless it should continue for some days, or after the maximum of the temperature and efflorescence has been passed for a day or two.



**DESQUAMATION.**—The desquamation is usually furfuraceous in character,—that is, the epithelium is cast off in fine flakes, and is thus distinguished from the large lamellar flakes occurring during the period of desquamation in scarlet fever. The desquamation begins in the order in which the efflorescence came out,—namely, first on the face and later on the chest. The furfuraceous character of the desquamation is especially noticeable on the sides of the nose. The disease usually runs its entire course in three weeks.

**PROGNOSIS.**—The prognosis of measles, as a rule, is good, but this depends almost entirely upon whether the disease is free from or accompanied by complications.

**DIAGNOSIS.**—In order that you should understand how difficult it sometimes is to diagnosticate measles, you must recognize that it is one of the most variable diseases with which we have to deal. During epidemics of undoubted measles cases arise which differ materially from the disease as it appears in its typical form, yet these cases, by producing the typical form in other individuals, prove that they are all caused by the same contagium. In like manner certain epidemics may be characterized by irregular forms of the disease, and, as true measles can occur a number of times in the same individual, the recognition of a sporadic case is often impossible. As in other diseases of the skin, we should recognize measles not by any particular dermal lesion, but by the peculiarities of the prodromal symptoms, the general course and location of the efflorescence, the time of the maximum of the efflorescence and temperature, and the character of the desquamation. Thus, a prodromal stage of three or four days, characterized by catarrhal symptoms of the eyes, nose, and upper air-passages, and a papular efflorescence appearing first on the face, differentiate the disease at once from variola, varicella, and scarlet fever.

**TREATMENT.**—The treatment of measles is essentially symptomatic. There is no known means of producing immunity from the disease or of shortening its course. It is a self-limited disease, and the treatment should be directed to protecting the organs which are most likely to be attacked by complications. Bearing in mind that the eye, the nose, and the throat are affected in the prodromal stage, that later the skin is in a very sensitive condition, and that the lung is frequently the seat of some complication, we should direct our treatment especially to the protection of these organs.

The child should be placed in a room kept at an equable temperature, 20°–21.1° C. (68°–70° F.), and well ventilated. The room should be darkened, and the eyes should be protected from light during the whole course of the disease. Unless this precaution is taken, the eyes are often seriously affected for many months after the measles itself has disappeared. The child should be kept in bed until the temperature has been normal for a few days, the efflorescence has faded entirely, and the desquamation has almost ceased.

The diet during the period of the height of the temperature should be

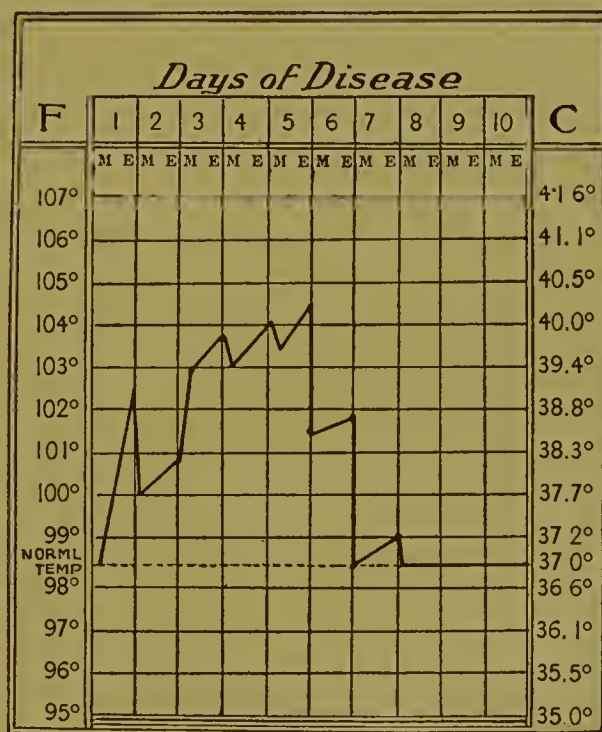
soup, milk, and bread. Later, when the temperature is normal and desquamation has begun, the child can gradually have its diet increased, until by the third week from the beginning of the attack it is having its usual food.

The cough, which is very troublesome at times, does not, as a rule, require any special treatment, as it will of itself in most cases pass off in a few days. While it continues it can be treated with some simple mixture, such as camphorated tincture of opium in cold water in doses of 0.3–0.6 c.c. (5–10 minims), to allay the irritation in the throat.

For the irritation of the nose I have found that atomizing the nares with some simple refined oil, such as oleum petrolatum album, is useful. During the invasion of the disease, however, these catarrhal symptoms are exceedingly difficult to control by any treatment whatever.

As at times there is great irritation of the skin during the period of efflorescence, this powder (Prescription 56, page 466) should be applied thickly to the entire body and limbs. In place of the powder some simple ointment, such as petrolatum, may prove to be more soothing.

CHART 17.



Typical measles.

As a rule, the child should be kept in an equable temperature for at least three weeks, and at the end of that time, if the desquamation has ceased, it may be allowed to go out of its room, and in pleasant weather out of the house a few days later. For several months, however, it should be carefully protected from sudden changes of atmosphere, as the catarrh of the air-passages is so likely to leave them in an extremely sensitive condition that a very slight irritation may cause its recurrence.



Before the child is allowed to leave its room it should be thoroughly bathed from head to foot in hot water. Although the contagium of measles has not the same tenacity for clothing as the contagia of variola and scarlet fever, yet the room should be thoroughly disinfected after the child has left it. This can be done in the same way that I have described to you in speaking of scarlet fever; but the extreme precautions taken in the latter disease are not considered necessary for the prevention of the extension of measles. If the carpet had not been removed when the child was put into the room, it can be taken from the house and thoroughly cleansed before it is brought back. The bedclothes and everything that can be washed should be thoroughly boiled. The room should be cleansed and the windows should be allowed to remain open for several days, as fresh air is one of the best means of eradicating the micro-organisms connected with the exanthemata.

This chart (Chart 17, page 579) shows the temperature as it usually occurs in the typical and regular form of measles.

Before speaking any further of measles I will show you here in the isolating ward at the Children's Hospital a case which illustrates so fully a typical picture of the regular form of measles that it will be very instructive for you to examine it.

This little girl (Case 249), six years old, after exposure to measles fourteen days ago, was attacked with lachrymation, coryza, cough, and a temperature of 39.4° C. (103° F.).

CASE 249.



Typical condition of the face in measles. Female, 6 years old.

On the second day from the beginning of the invasion the temperature fell to 37.7° C. (100° F.), but yesterday it rose again, and to-day, as you see by the chart, is 40° C. (104° F.). Later yesterday afternoon an efflorescence, papular in character, appeared on the face, and, as you see, has now extended to the neck and thorax. The disease is now at its height. You see the swollen condition of the eyes, nose, and entire face; also the extreme photophobia from which the child is suffering, the presence of considerable lachrymation, a continual, short, dry cough, and the extensive coryza. You will also observe how the papules have coalesced on the face, and are of a darker color than the widely separated lesions on the chest.

When you have once seen a case of this kind you will never have any difficulty in making your diagnosis in a typical case of measles at the height of the stage of efflorescence.

In this next bed is a boy (Plate VII., Case 250, facing page 551), eight years old, who is at the height of the efflorescence of an attack of measles.

He was seized with the usual prodromal symptoms of cough, coryza, and lachrymation five days ago, and to-day has the different stages of the typical lesions of measles represented on his face and chest. You will notice how the conjunctivæ are reddened, and how the eyes, nose, and lips are swollen, although this swelling is not so intense as in the case of the little girl (Case 249) whom I have just shown you. The efflorescence in this case has run a very rapid course, beginning on the face in so intense a form that the desquamation has already appeared, although the efflorescence on the chest is in a much earlier stage of development. The papules and macules have, as you see, coalesced on the cheeks and chin, while they still appear as large, deeply reddened lesions on the forehead. On the chin and neck you will notice the areas of normal skin appearing like white blotches, their boundaries



determined by the clusters of papules. On the side of the nose you see a slight desquamation, which has the furfuraceous character that I have already described to you as typical of measles. You will notice that on the chest the papules and macules are much smaller in size, are of a much lighter color, and in some places have assumed a crescentic shape.

This case represents the typical efflorescence of measles, and up to this time has not shown evidence of any complication. Both this boy and the girl (Case 249) have received no drugs directly for the measles, but have been kept in a dark room to protect the eyes, and have been surrounded by an equable temperature. Their food has been milk, broth, and bread.

In this next bed is a boy (Case 251), three and a half years old, who is convalescent from an attack of measles. He was exposed to measles on the 2d of the month, and had his first prodromal symptoms on the 12th. These prodromal symptoms continued on the 12th, 13th, 14th, and 15th, making the prodromal stage four days. On the 16th a papular efflorescence appeared on his face, and desquamation began on the 21st of the month.

I merely show him to you as representing the usual time, ten days, in the incubation of measles, the rather prolonged prodromal period of four days, the appearance of the efflorescence on the face about the fifteenth day from the time of infection and lasting four days, and the desquamation beginning five days from the first appearance of the efflorescence.

**VARIATIONS IN TYPE.**—I have already referred to the important fact regarding the diagnosis of measles, that during epidemics and in sporadic cases the disease varies much in its type, and presents great variations in its prodromal stage, in its dermal lesions, in its desquamation, and in its entire course. I wish especially to impress this upon you, as it is through a lack of appreciation of this fact that the diagnosis of other diseases, such as rubella and various forms of erythema, is continually being made where, in fact, the disease represents one of the more unusual forms of measles. If these variations in measles were better understood, we should not find the disease rubella so often diagnosticated.

At times the stage of incubation of measles varies considerably. It may even be extended from the usual ten days to twenty-one days.

Instead of the usual prodromal stage, certain cases during epidemics of undoubted measles show few, if any, prodromal symptoms.

In this next bed is a boy (Case 252), seven and one-quarter years old, who was attacked with the prodromal symptoms of measles on the 9th of the month. These symptoms were a heightened temperature of about 38.8° C. (102° F.), a quickened pulse, cough, and coryza. On the 10th, 11th, and 12th the child felt perfectly well, had a good appetite and an almost normal temperature. On the following day, the 13th, he was found to have the papular efflorescence of measles on his face, and a temperature of 38° C. (100.5° F.) in the morning and 38.8° C. (102° F.) in the evening. It has been a very mild case, and, as you see, is now desquamating slightly.

I show him to you as representing one of the many variations which arise in measles, the variation in this case consisting in the child being perfectly well during the last three days of the prodromal stage, and thus showing prodromal symptoms only during the first twenty-four hours of the invasion.

In addition to the usual catarrhal symptoms which I have described, in some cases there are vomiting and sore throat. Again, instead of a considerable elevation of the temperature, it may be scarcely above the normal

degree. In addition to the other variations in the course of the prodromal stage of measles, cases have been noticed during epidemics of this disease where the catarrhal symptoms were absent. Epistaxis of a mild form, and not apparently connected with the more severe types of hemorrhage, is sometimes met with. I have seen it only occasionally.

The efflorescence, which in the typical cases usually consists of papules, or vesicles and papules, may vary so as to simulate closely a common erythema, constituting the form called *lævis*, or may closely simulate a papular erythema. Again, the efflorescence may in certain cases be represented by minute vesicles or milia, characterizing the form called *miliaris*. Any of these forms may be confluent, but not usually anywhere except on the face. There is another form of efflorescence which occurs in measles, is rare, and is of a more serious nature than the common benign forms which you will meet with ordinarily. This is called the hemorrhagic or malignant form, and is represented on the skin by small capillary hemorrhages. It is often rapidly fatal, and at times appears to be part of a general hemorrhagic diathesis represented by epistaxis, hæmaturia, and hemorrhages from other localities. The temperature in this form is not typical, as it does not remit in the prodromal stage, thus depriving us of an important means of diagnosis; but a doubt as to the nature of the disease does not last long, as the other symptoms soon become prominent. The more prolonged the course of this form the better the prognosis, for if fatal it is usually quickly so. It may be complicated by a malignant broncho-pneumonia.

The efflorescence, besides differing in its form, may vary to a great degree in its intensity. Thus, we may have every grade of papule or macule, from the smallest to the largest, and varying from a dark purplish to a light pink color. In like manner, although the arrangement of the efflorescence, especially on the chest, is somewhat crescentic, yet during epidemics of undoubted measles this crescentic shape is often absent. Instead of the efflorescence first appearing on the face and then extending to the thorax and extremities, we may find in undoubted measles that it begins first on the chest or some other part of the body; or the efflorescence may appear on the face and thorax simultaneously. We may also find that in certain cases the efflorescence appears first on the abdomen, or on the thighs, and yet the presence of other typical and undoubted cases of measles in the vicinity or in the same house assures us that we are dealing with the same disease. The efflorescence instead of lasting for a number of days may be evanescent and may subside within twenty-four hours. The entire absence of efflorescence is said to occur in some cases, but must be considered very rare, and its possibility has been doubted.

The desquamation of measles is of so light a grade that it is not surprising that in some cases, no desquamation whatever is detected. Cases where desquamation occurs without efflorescence are highly improbable, although such have been reported.

During certain epidemics of undoubted measles cases have not infre-



quently been noted where the post-aural and cervical glands were enlarged.

There is a form of measles, called the recurrent, which is closely allied to relapsing fever. The main characteristic of this form is the high fever. The temperature will sometimes be raised for five or six days, will then become normal for seven or eight days, and will then rise again with a recurrence of the symptoms. This is a very unusual form, and one which needs merely to be mentioned here. It is accompanied by the general symptoms connected with the nose, eye, and bronchi which are met with in the typical form of measles.

Relapses have been reported to occur in measles, but they must be very uncommon. I have never met with such cases.

In reviewing the pictures which I have endeavored to give you of these variations, it must be evident to you that, although in the large proportion of cases measles runs so typical a course that the diagnosis is very easily made, yet such great variations in type are always liable to occur that we should be extremely careful not to make a diagnosis of certain other diseases, such as rubella, except under unusual circumstances. This is important, because we know that during epidemics of well-marked measles all these great variations as to incubation, prodrome, efflorescence, desquamation, and the entire course not infrequently arise.

A case which occurred in my wards at the City Hospital during an epidemic of measles which took place in that institution illustrates how greatly the symptoms and appearance of the disease may vary. The cases occurring in the hospital were almost without exception of the typical form, in which no mistake could be made as to the diagnosis of measles.

A girl (Case 253) who was in the hospital, and who was exposed to infection from the patients with measles, after feeling perfectly well on the previous day, was found in the morning to have slight coryza, cough, and a papular efflorescence not confluent even on the face, small in size, light pink in color, and not crescentic. While the efflorescence lasted the appetite was somewhat lessened, and the temperature was about  $37.5^{\circ}$  C. ( $99.5^{\circ}$  F.). At the end of twenty-four hours the efflorescence had almost faded, and in a few days the general symptoms passed away, the patient's appetite had returned, the temperature had become normal, and she seemed perfectly well.

If this case had been met with as a sporadic one it would have been impossible to make the diagnosis of measles, and from its mild nature it would have been supposed to be some slight form of disease, such as rubella.

I have met with cases of this type quite frequently, both during epidemics and sporadically; their cause is always obscure, and in them the diagnosis between measles, rubella, and papular erythema is often impossible.

In this next bed is a little girl (Case 254) who is convalescing from measles and is slightly desquamating. The record states that she was attacked with cough, coryza, lachrymation, a temperature of  $39.4^{\circ}$  C. ( $103^{\circ}$  F.), a pulse of 120, and respirations slightly quickened. On the second day of the attack these symptoms abated somewhat, and the temperature fell to  $38.3^{\circ}$  C. ( $101^{\circ}$  F.). On the following day the temperature rose to  $39.7^{\circ}$  C. ( $103.5^{\circ}$  F.) in the morning, and in the evening to  $40.5^{\circ}$  C. ( $105^{\circ}$  F.). At this

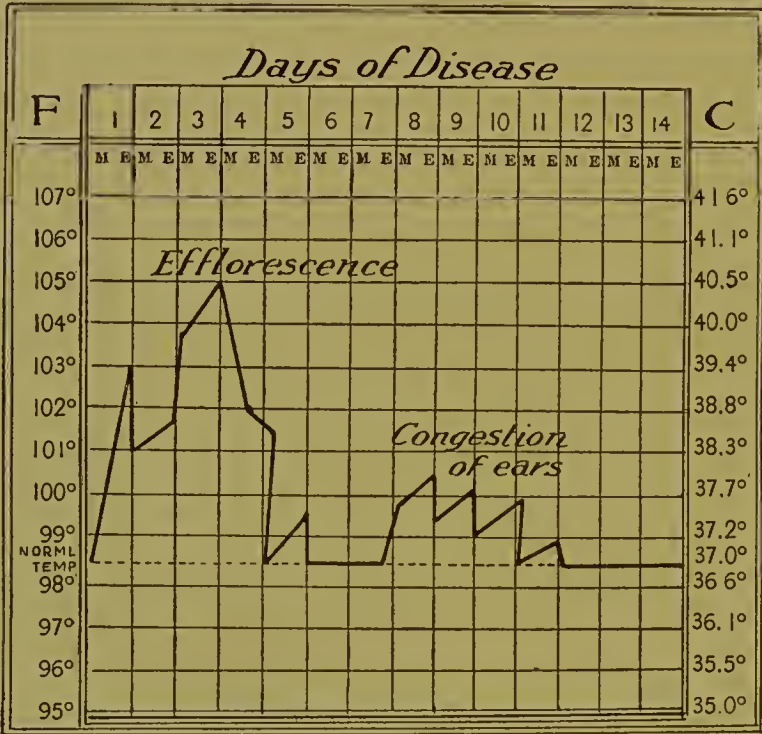


time an efflorescence, papular in character, appeared on the face, and by the fourth day had spread rapidly to the body and limbs. On this day the temperature fell to 38.8° C. (102° F.) towards the middle of the day, and by evening to 38.6° C. (101.5° F.). On the morning of the fifth day the temperature was 37° C. (98.5° F.) in the morning and 37.5° C. (99.5° F.) in the evening. The temperature was then normal for two days, but on the eighth day the child was found to have a temperature of 37.7° C. (100° F.), and to be complaining of pain in the left ear. A marked congestion of both membranæ tympani with a slight serous effusion was all that was detected. The temperature, after fluctuating from 36.6° to 37.7° C. (98° to 100° F.) for two or three days, fell to the normal, and the congestion of the ears subsided. During the time when the ears were affected the eyes were very sensitive to light, and there was considerable conjunctivitis, of which the child complained greatly. The cough was also very troublesome, and was evidently caused by an irritation of the mucous membrane of the throat, as at no time was any bronchial irritation detected.

It is to be noticed in this case that the congestion of the membranæ tympani occurred, as I have already described, during a period closely following the efflorescence on the face.

Here is the chart (Chart 18) which represents the temperature during the stage of invasion and efflorescence in this case, and also the accompanying mild congestion of the membranæ tympani which is so common in measles.

CHART 18.



Measles with congestion of membranæ tympani during stage of efflorescence.

COMPLICATIONS AND SEQUELÆ.—There are quite a number of complications and sequelæ which may occur in the course of measles. The most common of the serious ones are pertussis, pneumonia, and tuberculosis.

The first-named disease seems to have an intimate connection with measles, and its occurrence in the course of measles renders the prognosis more grave.

The bronchitis which is so common an accompaniment of measles sometimes appears in a more severe form, attacking the smaller bronchi as well as those of medium size, and may result in a broncho-pneumonia, which is much more common as a complication of measles than is lobar pneumonia.

The broncho-pneumonia does not, however, appear to be more severe when it arises as a complication of measles than when it occurs separately from that disease. Broncho-pneumonia as a complication of measles may occur very early in the course of the disease, even during the stage of invasion; but it occurs most commonly towards the end of the second week.

When, therefore, after the efflorescence has faded and the fever has subsided, the temperature again rises without evidence of local irritation in the throat, ear, or glands, we should suspect that a broncho-pneumonia is developing.

The additional symptoms of quickened respiration and the movement of the *alæ nasi* will render still more probable the supposition that this complication is arising, even though nothing abnormal is detected in the lung itself. This absence of abnormal physical signs in the lung in the early stage of broncho-pneumonia is quite common, and I shall defer a further description of them, as well as of the disease itself, until a later lecture (Lecture XLIX., page 962). In infants the temperature of tuberculous broncho-pneumonia does not seem to differ very much from that of ordinary non-tuberculous broncho-pneumonia.

The congestion of the larger bronchi, which appears to be almost a part of measles, may become subacute and chronic, instead of, as is usually the case, passing off soon after the maximum of the temperature and efflorescence.

Pleurisy may occur in the course of measles, but is not so common as pneumonia.

Among the rarer complications of measles are empyema, endocarditis, pericarditis, and membranous laryngitis.

Catarrhal laryngitis and tracheitis are not infrequent accompaniments of the acute stage of measles. Œdema of the glottis is rare, but has been known to occur.

When an otitis occurs as a complication of measles it is characterized by the symptoms which I have already described (page 575). In treating this complication the nose and naso-pharynx should be kept as clear as possible. The ear should be, as in the cases which I have already described in speaking of the treatment of the ear in scarlet fever, gently inflated by means of the Politzer bag, and the atropine solution (Prescription 70, page 559), together with dry warmth, should be used.

A case which came under my observation illustrates so well this aural complication occurring in measles that I shall report it to you.

A girl (Case 255), one year and seven months old, previously well, was attacked on March 6 with coryza, cough, lachrymation, a heightened temperature, quickened respirations, and a quick pulse. An efflorescence of measles appeared on the face on the following day, and the child felt sick, coughed continuously, and had a hoarse voice. The respirations varied from 36 to 40, the pulse from 170 to 180. The skin was hot and dry, and the throat was somewhat reddened. In the afternoon the temperature in the axilla was found to have risen to 40.2° C. (104.8° F.). She vomited and had a convulsion. The nervous symptoms passed off in a few hours, free perspiration followed, and the cough



became somewhat looser. At 8 o'clock in the evening the temperature was  $40.1^{\circ}$  C. ( $104.4^{\circ}$  F.), the respirations were quickened, and the pulse was rapid. Nothing abnormal was found on physical examination of the chest. During the night she was somewhat delirious, and very wakeful and fretful. The temperature remained at about  $40^{\circ}$  C. ( $104^{\circ}$  F.), the respirations were rapid, and the *alæ nasi* moved so perceptibly that it seemed as though a pneumonia must be developing. Frequent and careful examinations of the lungs, however, failed to show anything abnormal. She continued to be very restless during the night, and the efflorescence appeared thickly on the abdomen and legs, but very slightly on the chest. She complained of pain in the chest from the continuous cough, but did not show any symptoms of pain or discomfort elsewhere. Towards morning it was found that an otitis of the left ear had developed, which in a few hours caused perforation of the *membrana tympani*. As soon as there was a free flow of pus from the ear the temperature fell to  $38.3^{\circ}$  C. ( $101^{\circ}$  F.), the respirations became quiet and normal, the *alæ nasi* ceased to move, and the child fell into a quiet sleep. On the next day the efflorescence was pronounced all over the body, face, and extremities. From this time the measles ran its usual course, and was followed by desquamation and complete recovery.

The aural complication, however, proved to be very intractable, and, although it was carefully treated by Professor Blake, lasted for many months. The perforation of the *membrana tympani* did not completely heal for over a year, but the case finally resulted in complete recovery without any disturbance of hearing.

In addition to the conjunctivitis which is a common accompaniment of measles, and which, as a rule, requires no treatment beyond the protection of the eyes from light, the inflammatory process may extend to the deeper tissues of the eye and cause other grave lesions, such as blennorrhagic conjunctivitis, keratitis, and iritis. These complications should be treated at once by a skilled oculist.

Tobeitz has called attention to the deleterious influence of measles in rendering more active any subacute or chronic affections of the eye which may have existed previous to the disease.

In a number of cases an acute swelling of the thyroid gland may take place during the course of measles. This swelling of the thyroid gland may even cause marked dyspnoea by pressure, but it usually disappears in two or three days. In some cases, however, a formation of pus has taken place, followed by destruction of a part of the gland. In intractable cases of this kind it has been found that the external application of iodine is useful.

Enlarged cervical glands are not so common in measles as in scarlet fever, but they may occur, and may even prove serious from the occurrence of suppuration.

At times, at the height of the efflorescence, albumin may appear in the urine; but this is frequently merely a transient congestion of the kidney, due to the high temperature, and corresponding to the same condition in the period of efflorescence in scarlet fever. Nephritis may complicate measles, as it does scarlet fever, but it is comparatively rare.

The irritation of the intestine, which I have already referred to as occurring commonly during the height of the efflorescence and temperature, sometimes becomes much more severe from the development of colitis as a complication.



The most common sequela of measles is tuberculosis. This may occur either as a general miliary tuberculosis or as tuberculous disease of any of the organs or the joints. Tuberculous disease of the joints seems to show a special predisposition to follow attacks of measles. It is noticeable that where a patient with a tuberculous joint has an attack of measles the process in the joint is apt to become temporarily more active, and the prognosis is consequently more grave. The organ which in measles is most commonly affected by tuberculosis is the lung, and the most common form of tuberculosis of the lung is a tuberculous broncho-pneumonia. You must remember, however, that a tuberculosis of the lung may often occur as a sequela of measles where pneumonia has not been present. In infants the temperature of tuberculosis, as has been observed by Holt, does not seem to differ very much from that of an ordinary broncho-pneumonia. In regard to the relation which exists between measles and tuberculosis, we should appreciate the danger, which seems to be a serious one, that the micro-organism of measles will render active an old and quiescent tubercular nidus, whether it be in the bronchial or the cervical glands or elsewhere.

I have here a case to show you which represents the infection of a patient with measles by the bacillus tuberculosis.

This girl (Case 256), six years old, was always well until about one year ago, when she had an attack of measles. Although there was no acute pulmonary affection following the attack of measles, she began to be affected with slight dyspnoea and a cough about one month after the measles had ended. Since then these symptoms have increased, and she has lately had swelling of the feet and has complained of a general malaise. She has also lost considerably in weight and strength. On physical examination dulness is found at the apices of both lungs, and over the dull areas coarse and fine moist râles. Nothing abnormal is found in connection with the heart or kidneys. The temperature varies from 37.7° to 38.8° C. (100° to 102° F.), the respirations from 30 to 50, and the pulse from 120 to 130. An examination of the sputum shows the bacillus-tubercle to be present. This is evidently a case of pulmonary tuberculosis following an attack of measles.

Another sequela, though a rare one, is paralysis. Cases thus complicated have shown mostly a paraplegia, and, according to Osler, frequently can be classified as post-febrile polyneuritis, although it is possible that some of them may be due to a rapidly ascending myelitis.

A very rare sequela of measles is the disease noma (*cancrum oris*). I have here in one of the isolating rooms a case which illustrates the sequence to measles of broncho-pneumonia and noma.

This child, a girl (Case 257), four years old, had a severe attack of whooping-cough. When the whooping-cough had lasted six weeks, she was attacked with measles. Towards the end of the second week of the measles the child was attacked with a broncho-pneumonia. This pneumonia was not of an unusually severe type, but it lasted for five or six weeks and left the child in a very weakened and debilitated condition. During the pneumonia the child was not well cared for, and this complication arose, for which she has entered the hospital.

As I shall refer to this case later (page 793), when speaking of diseases of the mouth, I shall show it to you now merely as a case of noma which I am having actively treated, but in which the prognosis is very unfavorable. When noma occurs as a complication of measles and pneumonia it is generally fatal.

**RUBELLA** (Rötheln. German Measles).—It is now almost universally believed that there is, in addition to variola, varicella, scarlet fever, and measles, a highly infectious acute disease accompanied by an efflorescence on the skin which is distinct from these other members of the group of exanthemata. While we must recognize the propriety of mentioning the existence of this disease when speaking of this class of affections, we must also acknowledge that it is the weight of opinion, and not of proof, which has characterized rubella as a disease *sui generis*. The cause, the symptomatology, and the resulting diagnosis and treatment of rubella must be left for future investigation, until the special micro-organism which produces it and that which produces measles can be separated bacteriologically. The difficulty which arises in differentiating rubella from the other diseases of this class is chiefly in distinguishing it from measles. We cannot describe a typical case of rubella in such a way as to enable us to diagnosticate the disease in a sporadic case. On the other hand, this can be done so readily with the other exanthemata that we can at once diagnosticate a sporadic case of these diseases. Rubella is described in many ways by observers in different localities, but is usually spoken of as essentially a highly infectious disease, with an incubation of two or three weeks, with slight or no prodromata, and with a slightly raised temperature, accompanied by mild catarrhal symptoms, and often by sore throat and swelling of the cervical and post-auricular glands.

The efflorescence is commonly described as papular or macular in form, of light grade, often evanescent, and seldom showing any desquamation. Complications or sequelæ following rubella are said to be uncommon. If you will bear in mind what I have told you concerning the variations which occur commonly during epidemics of undoubted measles, you will see at once that this description of rubella is one which may be applied to many mild cases of measles. As, however, epidemics arise in which these characteristically mild symptoms occur in many cases, and as these give rise to like cases, it is probable that in the future a micro-organism distinctive of rubella may be found.

Bearing these facts in mind, we can merely say, regarding rubella, that its diagnosis cannot be made in a sporadic case, that the prognosis is good, and that the treatment is the same as that of a mild case of measles.

It may perhaps aid you to carry in your minds more clearly the characteristics of the group of exanthemata, which I have endeavored to explain to you, if in a few words I speak of this group of diseases as a whole.

In none of these diseases has the specific organism been determined. When it shall have been, its detection will enable us to state definitely which disease we have to deal with, whether measles or scarlet fever, and even in the atypical cases of measles we can decide whether we have a case of true measles or of some disease such as rubella, which closely simulates its irregular forms.

By referring to this table (Table 97) you can at a glance ascertain the chief points of differential diagnosis in the exanthemata. The figures and



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„ (Diseases),	.	.	SCHECH.

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„ (Text Book of),	.	.	WINCKEL.
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„ (Practical),	.	.	GIBBES.
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„ „ (Exam. Quests.),	.	.	SMITH.
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Prescribing and Treatment of Children's Diseases,			MUSKETT.
Regional Anatomy,	.	.	M'CLELLAN.
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„ R. C. P. Laboratory, Edinburgh.			
Septic Diseases,	.	.	CHEYNE.
Sexual Organs (Diseases),	.	.	FULLER.



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" (Aseptic),	.	.	.	LOCKWOOD.
" (Exam. Quests.),	.	.	.	SMITH.
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" (System),	.	.	.	HARE.
" (Physical and Natural),	.	.	.	HAYEM & HARE
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" and Nose (Malignant Disease of),	.	.	.	NEWMAN.
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Tumours (Intracranial),	.	.	.	BRAMWELL.
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Zoology (Exam. Quests.),	.	.	.	SMITH.
" (Illustrations of),	.	.	.	SMITH & NORWELL.
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